COAL AGE

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A Shift Ends At Willow Grove See p. 47

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● **Born** during the stirring war days because federal regulating authorities wanted to deal with the bituminous industry as a unit, National Coal Association signalizes its twentieth year with a meeting this month in Pittsburgh. Once again questions of government control will be a major theme of the deliberations. The high-spots of the two-day conclave will be reported in the next issue.

● **Complete mechanization,** first tested out by Hanna at Fairpoint, proved so successful that mechanical loading and cleaning have been given large-scale application by that company. Double- and triple-shifting also are standard practice. Russell McHugh tells the story of the conversion of Willow Grove to mechanical loading on page 47; Ivan A. Given describes the topworks developments in the story on page 65.

● **Can** beauty be the handmaid of utility and profit? Yes, say builders, who point that modernization of structural design is beginning to follow modernization of equipment in new preparation plants. What direction this latest step is taking and what progressive designers hope to achieve thereby will be outlined by W. F. Barnes, one of the pioneers in the new movement, in November.

● **Faced** with increasing power costs due primarily to lengthening hauls and heavier pumping loads, North-East Coal Co. decided that the best answer for its Auxier operation would be to revert to generating its own power. So a plant was built on the site of one abandoned in 1924 for purchased power. The story of this second change-over starts on page 63.

● **In December,** Coal Age will publish its Annual Model Mining Number—seventeenth in a notable series of detailed studies of major producing properties. This year the Bell & Zoller mines, which have made an outstanding record in modernization, will be featured. The December articles will give a complete survey of all phases of operation and the factors which have contributed to this record.

● **While** industry battles with its immediate problems, many of its future trends are being determined in the research laboratories of the world. Forward-looking management, therefore, must keep in touch with these activities. What the chemical group thinks of the possibilities of coal hydrogenation—in which there is a reviving interest—is briefed in the American Chemical Society report on page 98.

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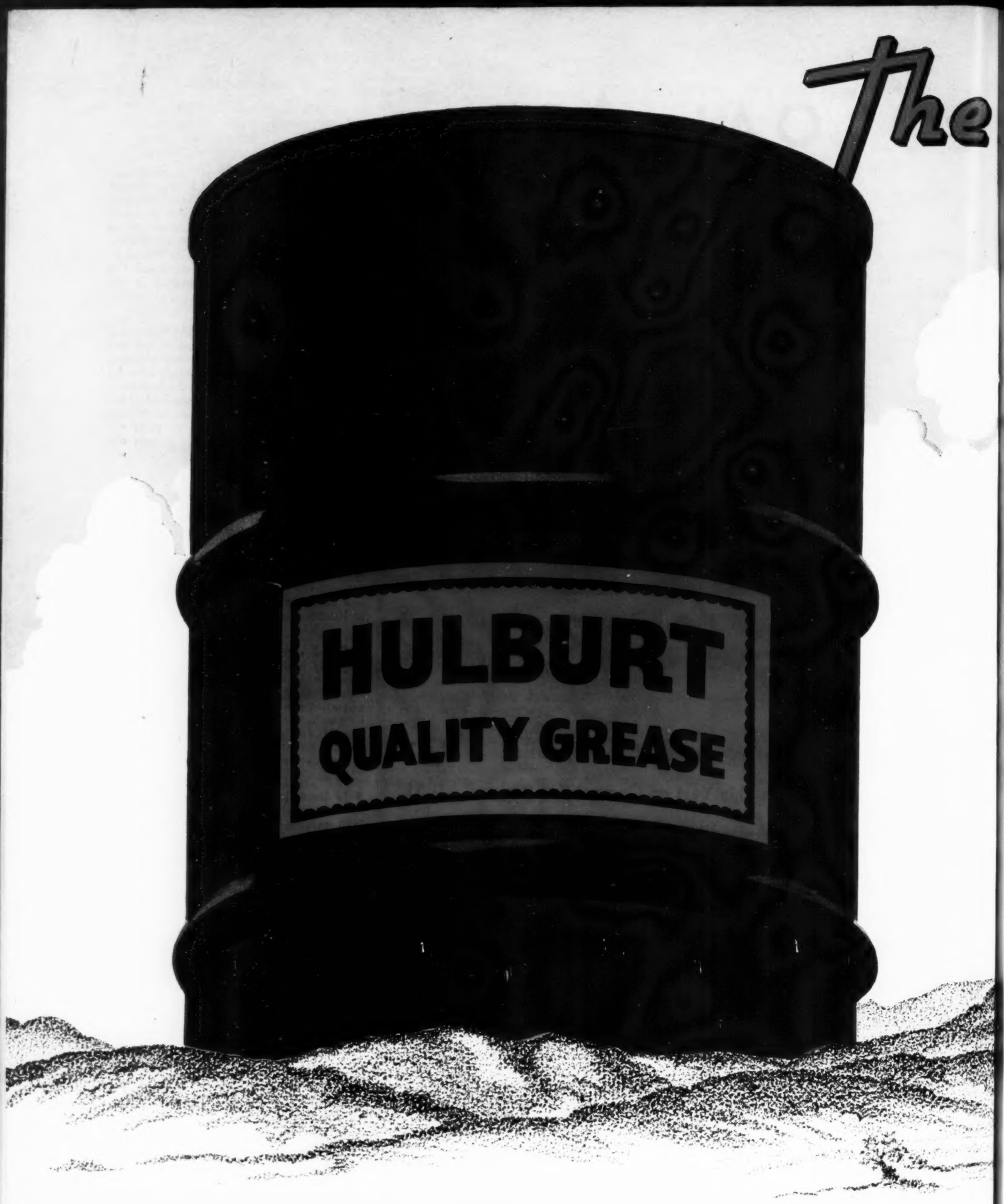

HULBURT

COAL AGE

Established 1911—McGraw-Hill Publishing Company, Inc.

DEVOTED TO THE OPERATING, TECHNICAL AND BUSINESS PROBLEMS OF THE COAL-MINING INDUSTRY

SYDNEY A. HALE, *Editor*

October, 1937

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Corrosion

BECAUSE most mine water is acid, that condition usually is stressed to find an explanation why pipes are destroyed. But oxygenation by entrained air may well be the cause, especially where the water is alkaline or neutral, and acidity, therefore, cannot be blamed for the corrosive action. When oxygen attacks iron, the oxide thus formed is washed off by the moving water, leaving the pipe unprotected against further corrosion.

Too high a lift subjects the water in a suction pipe to a pressure much lower than atmospheric. Hence the air expands and no longer is held by the water but segregates into bubbles, large and small. On the other hand, if the water is brought to the pump under a pressure somewhat greater than atmospheric, there will be less corrosion, for the air cannot free itself from its liquid prison. Where air is part of a continuous flow, it is absorbed by the water under the high pressure of the discharge pipe. Water that has to be sucked into pump barrel or volute preferably should be nearly free of occluded air or the air will segregate to such a degree that it cannot be absorbed.

When, as the result of flooding, water forces itself into places from which air cannot be driven, the atmosphere thus compressed will fill the water with gases that will be emitted later when the pressure is released. These gases, however, usually are methane or carbon dioxide and do not corrode metal as does oxygen. They may interfere with the effective operation of the pump and may be explosive or dangerous to life, but they will not injure pipes or pumps. Finally, in looking for sources of corrosion, electrolytic action should not be forgotten, for it may be derived either from stray currents of electricity or soil conditions. The insertion of a length or so of pipe, not conductive of electricity, should reduce this trouble.

Dolomite Dust

SOMEWHAT generously bespread over the earth's surface, dolomite is a product about as cheap as limestone, though freight rates and difficulties in grinding in cases may make delivered dolomite dust the more costly. Strictly speaking, it is a carbonate of calcium combined with a carbonate of magnesium ($MgCO_3.CaCO_3$), but the combination may run the gamut all the way from a magnesium carbonate, or magnesite, at one end to a calcium carbonate, or calcite, at the other.

Magnesium carbonate gives up carbon dioxide more readily than does calcium carbonate, absorbing heat; hence, in the face of a mine explosion it might be expected to cool the flame more promptly and efficiently than the other material. According to A. Rose, magnesium carbonate begins to lose carbon dioxide between 392 and 572 deg. F., but O. Brill declares that, if it is moderately hygroscopic ($MgCO_3.\frac{1}{2}H_2O$), the action will begin at 275 deg., be well marked at 509 deg. and still more active at 842 deg. Trihydrated magnesium carbonate ($MgCO_3.3H_2O$) loses 15.27 per cent of water and carbon dioxide at the boiling point of water, says H. Bechurts, and at 392 deg. more water and carbon dioxide are given off.

Calcium carbonate, however, waits until it is

at a temperature of 977 deg. before it begins to dissociate. Combination of the carbonates in dolomite may delay the action of magnesium carbonate, but H. Grunberg's experiments do not seem to show any such tendency. However, other factors besides the volatility of carbon dioxide and water may demand consideration.

Money Talks

ACCIDENT-PREVENTION WORK naturally made its first strongest appeal to men whose response to human suffering was keen. The tragedy of human waste so appalled them that they became willing converts to the safety-first movement. And no one rejoices more than men of this school in the improvement which has been effected in accident records in recent years. Occasionally, however, this genuine rejoicing is tinged with an undercurrent of resentment that more stress is now laid upon the financial than upon the humanitarian aspects of the campaign.

While this resentment does credit to their hearts, the testimony that safety has grown with the shift in attack cannot be gainsaid. This, too, is easy to understand. No normal man wants to encourage accidents, yet this ready acceptance of the safety idea in principle is often a deterrent to direct action in practice. In this contrary world, the penalties of wrongdoing are the shining advocates of virtue. So, too, in safety, impressing employers and fellow workers with proof that accidents are costly to them as well as to the immediate victim produces results.

Self-Ignition

UNTIL there is an index of self-ignition, classification of coal will be incomplete. More important than some other indexes, it probably has been left to one side because of the difficulties involved in its formulation. We have yet to learn why some coals fire easily and some do not. Only a modicum of heat seems necessary to turn a coal from safe to combustion temperatures so that a small abstraction of heat short of the ignition point may prevent a coal from firing spontaneously. All coals heat, but only some of them enough to produce self-ignition.

Under certain conditions some coals attain that heat, and some fire possibly because they are reactive at low temperature or from the presence of reagents or catalyzers. Carbon dioxide helps to subdue such fires, especially when held beneath the surface of the pile so that it cannot diffuse and escape. Carbonates which might emit carbon dioxide and moisture might serve to provide that inert gas, if they did not themselves make the coal more reactive. Whether they do or do not is not known, nor whether the coal itself would cause them to liberate carbon dioxide and moisture at temperatures low enough to cool the coal mass and prevent ignition.

But the coals which themselves produce the most carbon dioxide are the worst examples of spontaneous combustion. They would seem to need no further admixture with sources of the gas. The problem is involved and needs experimental study before reliance is placed on rock-dusting with carbonates to form a deposit on the mine floor that will prevent a fall or roof or side coal from starting an underground conflagration.

Hydrogenation

ONE might be intrigued by the prospect of using a vehicle such as tetralin in place of hydrogen for the hydrogenation of coal, but at 12 cents a pound tetralin costs $1.32 a pound for its hydrogen content, whereas the selling price of hydrogen (now a drug on the market and selling for what it will bring) is only about 33.7 cents per pound. Should coal be hydrogenated with hydrogen, the price of that gas inevitably would be much higher, and the price of tetralin and similar hydrogenating bodies, should they be used instead of hydrogen, would be reduced; but the gap to be bridged is too great to offer much prospect for the use of such a solvent. Its use, therefore, seems likely to be limited to research, and the authors of the papers at the meeting of the American Chemical Society in Rochester, N. Y., last month wisely forbore to suggest its commercial use.

COMPLETE MECHANIZATION

+ Plus Three-Shift Operating Schedule

Feature Hanna's Willow Grove Mine

By RUSSELL McHUGH
Assistant Mining Engineer, Hanna Coal Co.
St. Clairsville, Ohio

ONE OF THE LATEST additions to the list of all-mechanical operations in Ohio is the Willow Grove No. 10 mine of the Hanna Coal Co., about three miles south of St. Clairsville, Belmont County, operating headquarters for the Hanna company. Originally opened on the hand-loading basis, the mine had been idle a few years before it was taken over by Hanna, which reopened it, retaining the hand-loading system, in January, 1934. At that time, the Fairpoint No. 9 property of the company was on a wholly mechanical-loading basis. On the strength of the results attained at Fairpoint, it was decided to convert Willow Grove to full-mechanical operation to replace Fairpoint, soon to be worked out.

A new preparation plant with coal-washing facilities to supplement mechanical loading underground was the first step in the conversion of Willow Grove. While this plant (see p. 65 of this issue) was under construction the mine continued on the hand-loading basis until about the middle of April, 1936, whereupon operations ceased until May 11, 1936, when the first car of coal was dumped under the all-mechanical program in force since that time.

Other major improvements made since the property was taken over, either as a result of or in anticipation of mechanical loading, include installation of two new inside substations, a modern underground machine shop, an underground car-repair shop, a new system of tipple tracks and a new air shaft. These are in addition to other improvements which will be enumerated in the discussion to follow. Present daily output at Willow Grove No. 10 (three shifts) averages close to 5,300 tons of raw coal, compared with 3,000 tons (one shift) at the time hand-loading was discontinued.

Principal equipment now used in the development and operation of Willow Grove mine is listed in Table I. The Differential mine cars, averaging 4½ tons per car, are of a new type developed at the Fairpoint No. 9 mine. The equipment listed in Table I serves three shifts, on two of which five wide- and five narrow-work units are operated. Four wide- and four narrow-work units on the third shift bring the total number of machine shifts per day to fourteen wide and fourteen narrow. In addition to the equipment shown in Table I, a spare Jeffrey locomotive, Oldroyd cutting machine and Whaley "Automat" loading machine are kept on hand.

Table I—Major Underground Equipment in Use at Willow Grove No. 10 Mine*

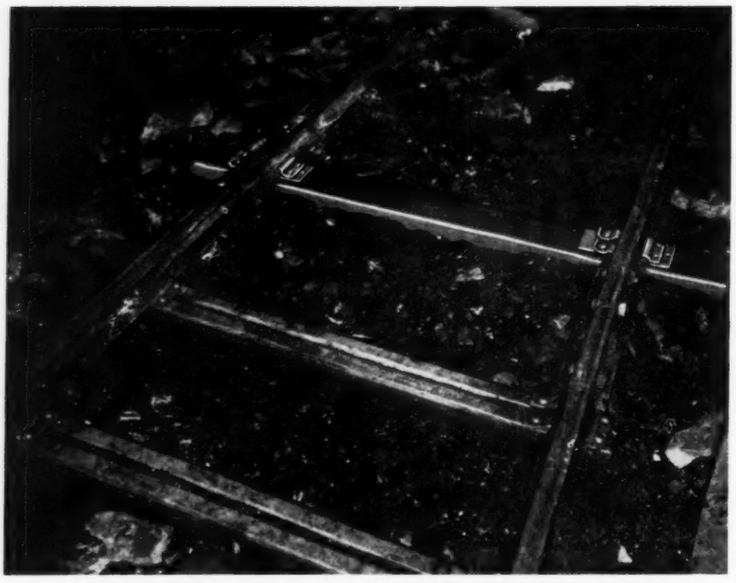
	Number
Main-Line Haulage:	
Jeffrey 16-ton locomotives	1
Goodman 13-ton locomotives	1
Intermediate Haulage:	
Jeffrey 8-ton locomotives	1
Jeffrey 10-ton locomotives	1
Sectional Haulage and Service:	
Jeffrey 6-ton locomotives	6
Goodman 30-B locomotives	4
Jeffrey supply locomotives	1
Jeffrey "grease-wagon" locomotives	1
Coal Transportation:	
Differential cars (averaging 4½ tons)	168†
Drilling:	
Chicago Pneumatic and Jeffrey post-mounted drills	10
Cutting:	
Oldroyd track-mounted cutters (9-ft. bars)	10
Loading:	
Whaley No. 3 Size "Automat" loading machines	10

* Exclusive of spare equipment.
† Including 24 on order.

The seam worked at Willow Grove is the No. 8, or Pittsburgh, averaging about 5 ft. 2½ in. in thickness. In this thickness there is about 4 ft. 11 in. of coal, exclusive of bands and impurities definitely separated from the rest of the seam. Above the coal is 10 to 12 in. of drawslate, or "stone," which is taken down as each cut is loaded. For every 100 tons of clean coal an average of two carloads of stone is loaded and transported to the outside.

The main haulage entry serving the mine is laid with 60-lb. rail with Thermit-welded joints (*Coal Age*, April, 1936, p. 137). This stretch of track, about two miles in length, extends from the tipple to the main haulage junction located on the Main Butts West at 19–20 North Face entries. This haulage road is protected with a 1-in.-thick mixture of water, sand and cement applied pneumatically under high pressure by the Gunite Construction Co. By this application serious injuries to men have been reduced to a minimum and falls have been eliminated. About 1¼ miles of aircourse also has been given similar treatment.

Main-line haulage locomotives transport coal from the junction on the Mains West at 19 North Face entry to the outside. Each of the two locomotives operating hauls about 595 cars (coal and stone) per day of three shifts. Cars of coal



Contrasts in composite ties used in laying 40-lb. entry track. In the rear is the earlier tie consisting of a treated wood member to which are bolted plates carrying the usual clips. In the foreground is the latest composite unit, consisting of a treated base to which is bolted a standard steel tie.

and stone are dumped in trips without uncoupling. The same locomotive that brings out the trip pulls it across the tops of the coal and rock bins, of which there are two with a capacity of 150 tons each for coal and one, with a capacity of 50 tons, for stone. As the trip moves slowly along on the track over the bins, two "Dongbeater" pneumatic dumpers, which move back and forth on tracks on each side of the loaded track, tip the bodies of the cars to one side or the other to discharge the coal. In dumping, an arm operated by compressed air contacts the car body at the bottom on one or the other side, lifting the body off the truck frame on that side and raising it to an angle of 45 deg. The opposite side of the body automatically folds down 90 deg. to form an apron. One "Dongbeater" unit can dump cars at the rate of 2.56 per minute. Incidentally, the 168 Differential cars (including 24 with 6-in. higher sideboards on order) replaced 600 2¼-ton wood cars.

Approximately 140 Bethlehem No. 2½ 40-lb. turnouts with cast frogs are in use in the mine at the present time, about half of which are into room necks being turned and the remainder into wide working rooms. Also in place are about twenty No. 4 40-lb. turnouts, four No. 5 60-lb. turnouts and one No. 6 special turnout (60-lb. with 10-ft. switches).

To facilitate the laying and recovery of 40-lb. track on headings, Willow Grove last year started the use of composite ties. The first type consisted of a 3x5-in. creosoted tie to which was bolted tie plates on which the conventional steel-tie clips were riveted. Major objectives were the ballasting, aligning and surfacing qualities of the wood tie with the ease of installation and removal of the steel tie. Treating of the wood part of the tie assures a greatly increased life—a necessary factor in a tie to be used over and over—and also offers the possibility of a saving in tie purchases. At the first of September, 8,432 ft. of room entry was laid with this type of tie, 1,926 ft. was laid with 40-lb. steel ties, 172 ft. was laid with common wood ties, and about 500 ft. was laid with the new Koppers "Armoored" composite tie.

The "Armoored" tie differs from the earlier composite tie in that a standard Bethlehem steel tie is bolted to a 3x5-in. creosoted base shaped to fit the steel tie. A more substantial unit is the principal result. Differences in the construction details of the two types of composite ties are shown in an accompanying halftone.

Power for the operation of underground equipment is taken into the substations by cables (4,000 volts, a.c.) buried in trenches 12 to 18 in. deep cut between the track and the rib. From the surface to the Mains West station (two 200-kw. Ridgeway m.g. sets), about 1¾ miles, General Cable steel-armored metallic cable is employed. This substation was covered with a pneumatically applied mixture of water, sand and cement, using wire-mesh reinforcement in places. Between the Mains West station and the other substation on 19 North Face entry (two 150-kw. Ridgeway and General Electric m.g. sets), a distance of ½ mile, Anaconda non-metallic "Duraseal" cable has been installed.

Trolley wire from the tipple to 19 North Face and Mains West junction is 6/0 Figure 8, a distance of about two miles. All other trolley wire is 4/0 Figure 8. Feeders consist of 1,000,000-circ.mil cable in main butt and main face entries, with 500,000-circ.mil and 4/0 cables

Narrow-work loading machine taking a cut out of a room neck

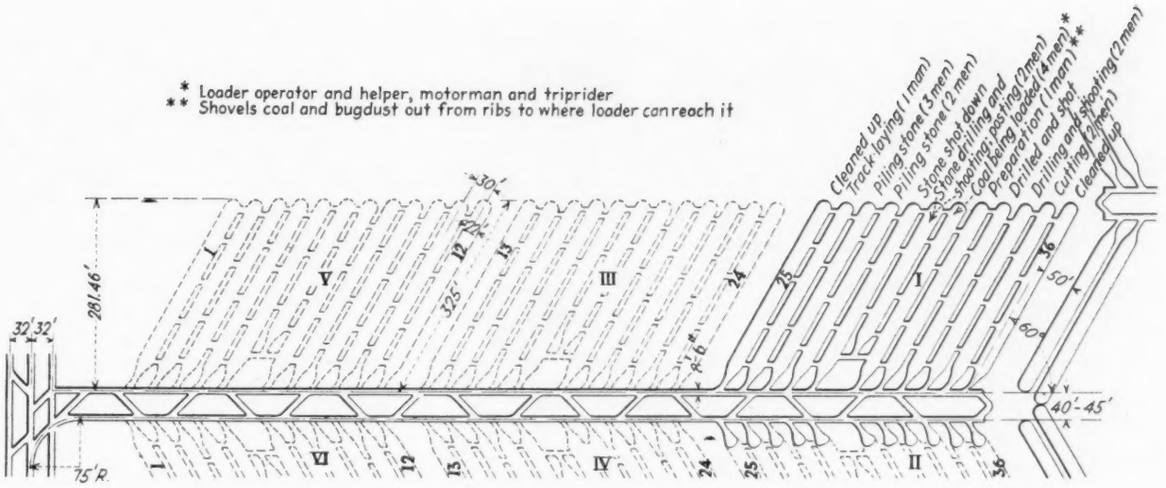


Fig. 1—Room-entry plan, showing method of working twelve-room panels, which are taken in the order indicated. Also shown is the crew-distribution and working cycle in a panel. The plan of timbering and stone disposal in rooms is shown in Fig. 2.

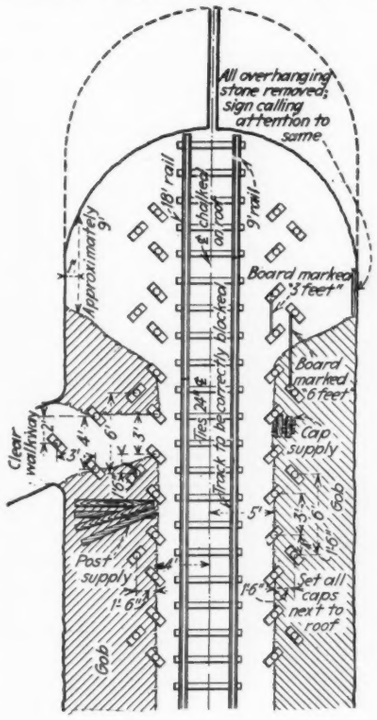
in room entries. On the 60-lb. main-line haulage, where joints are welded and four steel ties are used for every 30 ft. of track, cross bonds are eliminated, the steel ties serving in this capacity. All turnouts, however, are both cross and double bonded. All rail joints on 40-lb. track (not welded) are bonded and cross bonds are placed every 200 to 225 ft. Ohio Brass bonds are used throughout. A 4/0 return wire usually is installed, and is tied in to the track about every 275 ft.

Willow Grove uses about 572,000 kw.-hr. of electric current every month, divided about as follows: inside, 420,000 kw.-hr.; outside, 152,000 kw.-hr. Demand is approximately 1,200 kva. Total energy consumption per ton of coal shipped is slightly less than 6 kw.-hr., with a load factor of about 62 per cent. Power is purchased from the Ohio Power Co., and the average cost per ton is about 6c., made up of 4.3c. inside and 1.7c. outside.

Just beyond 19 South Face entry on the Main Butts we have constructed an underground machine shop in which all necessary machinery repairs and changes are made. The car-repair shop referred to above is located in the aircourse pit mouth, and is about 130 ft. long. Ventilating air for the mine is supplied by a 5x7-ft. Robinson fan set over a 50-ft.-deep shaft also coated with a mixture of water, sand and cement applied over wire mesh.

The normal operating schedule at Willow Grove No. 10 is three shifts a day, six days a week, with a half hour between shifts for the transportation of men and supplies. With a half hour for lunch, the first shift enters the mine at 11:15 p.m., starts work at midnight and quits at 7:30 a.m. The second shift enters at 7:15 a.m., starts work at 8:00 a.m. and quits at 3:30 p.m. The third shift enters the mine at 3:15 p.m., starts work at 4:00 p.m. and quits at 11:30 p.m. This cycle is repeated throughout the week, with the exception of Sunday, on which the crew normally starting inside at 11:15 p.m. enters at 11:30 p.m. instead, starting work at 12:01 a.m. Monday.

Fig. 2—Standard timbering plan and method of disposing of stone in rooms



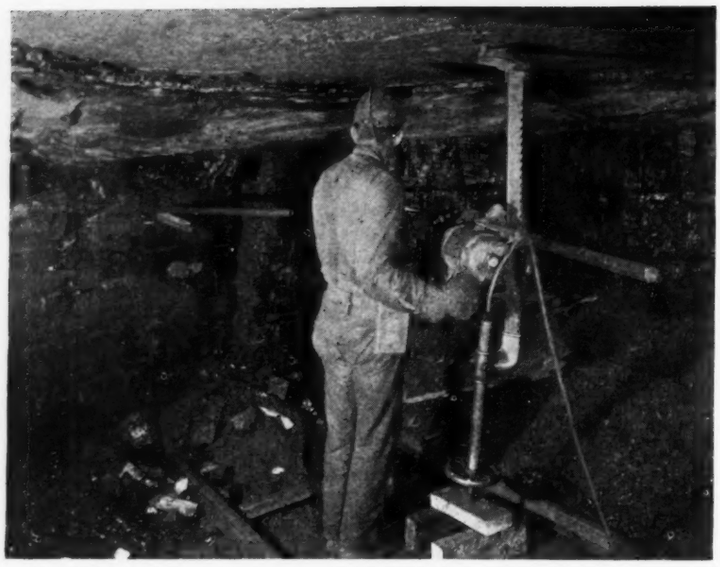
In order to operate the mine six days a week, it was necessary to establish a stagger crew, since each man on the various working units must be relieved one day each week. This stagger crew consists of 81 men, distributed per week as follows:

Wide units	48
Narrow units	17
Haulage	5
Trackmen and timbermen	4
Recovery men	4
Outside and other	3
Total	81

Mechanical-loading units at Willow Grove are divided into two classes: wide-work units, which produce about 78 per cent of the coal and are known as production units, and narrow-work units, which account for about 22 per cent of the output and are known as development units. The development units drive entries and turn room necks.

Face and main butt entries consisting of 8½-ft. headings on 32-ft. centers are employed to open up the working territory. Room entries, from which the major output is secured, consist of two headings 8½ ft. wide on 40- to 45-ft. centers. Where possible, room entries are driven into the end, whereupon rooms are worked out on the retreat. Rooms are worked in groups, or "panels," of seven or twelve each, each panel being separated from the next by a solid block of coal made by omitting a room, as shown in Fig. 1. A territory for a wide-work unit consists of one twelve-room panel or two seven-room panels.

Rooms are turned off each side of the panel entry on an angle of 60 deg. Spacing of the rooms along



Drilling a wide place. Note shear cut in center, stone over the coal and blasting barrel in place in hole to the left of the driller.

the center line of the heading is 34.64 ft., which makes the right-angle distance between room-center lines 30 ft. With a 22-ft. room, this leaves a rib 8 ft. thick between rooms. Room depth is 325 ft. The working cycle in a room entry is about as follows. As soon as the entry is driven up to its limit by a narrow-work unit, this same unit, or a similar unit, drops back and drives the necks for one panel in case twelve-room panels are being worked on that particular entry. Room necks are driven in about 40 ft. off the entry, at which point they reach their wide-unit width of 22 ft. A wide-work unit then takes the remaining room depth of 285 ft. At the proper time in the room advance, a narrow-work unit moves in on the opposite side of the entry and necks another room panel (as indicated in Fig. 1) so that it will be ready when the first is finished. This process of necking and driving is repeated on alternate sides of the room entry until it is finished.

Seventeen men make up a crew for a wide-work unit, while six men make up a narrow-work crew, as shown in Table II. It will be noted that no stone men or drillers are included in the narrow-work crew, as the machinemen do the drilling and shooting and the loading-machine operator handles the stone. In wide work, however, special men are assigned to these tasks. The distribution of a wide-work crew and the various steps in the cycle of preparation and loading are shown in Fig. 1.

All places are cut with Oldroyd track-mounted machines with 9-ft. cutter bars. In rooms, these machines make a cut 22 ft. wide. In addition to the undercut, headings are sheared on the right side and rooms are sheared in the center. The drilling plan for entries is given in Fig. 3. In face entries, the hole is loaded with $3\frac{1}{2}$ to $4\frac{1}{2}$ sticks of duPont No. 4 $1\frac{1}{2}$-in. pellet powder. In butt entries, this hole is drilled 1 ft. short of the back of the undercut.

Shotholes in rooms are placed as shown in Fig. 4. Center holes are started about 1 ft. below the stone and are angled so that they will be

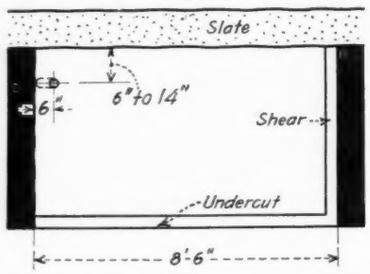


Fig. 3—Standard entry-drilling plan

Table II—Crew Make-Up on Wide- and Narrow-Work Loading Units, Willow Grove No. 10

	Number Wide	Number Narrow
Loader operators	1	1
Loader helpers	1	..
Machinemen	2	2
Motormen	1	1
Tripriders	1	1
Tracklayers	1	1
Drillers and shooters	2	..
Stone shooters, timbermen	2	..
Stone men	5	..
Preparation men	1	..
Total	17	6

6 in. below the stone at the back of the cut. These holes are charged with $2\frac{1}{4}$ sticks of pellet powder and are shot first. Rib holes are started about 1 ft. away from the side of the place and about 1 ft. below the stone. They are drilled parallel to the roof slate to a point 1 ft. short of the undercut, at which point they are supposed to be about 8 in. from the rib. In our 19 South Face section, these holes are loaded with $1\frac{3}{4}$ sticks of pellet powder, whereas $2\frac{1}{2}$ sticks are used in the 19 North Face section.

Holes are drilled with Chicago Pneumatic Nos. 472 and 473 and Jeffrey post-mounted drills. All places are bugdusted before shooting, which is done with blasting barrels and sulphur squibs. These blasting barrels take the place of the conventional tamping and consist of a length of galvanized pipe. A plug with a tapered hole is placed in the end of the pipe next to the charge. After a blasting barrel is placed in a hole it is held fast with a tapered wooden wedge.

Equipment used in developing a pair of headings consists of one Oldroyd cutter, one Chicago Pneumatic or Jeffrey drill, carried on the cutting machine; one Whaley No. 3 Size "Automat" loading machine and one locomotive. A crew will load in one shift of seven hours about eighteen cars of coal, averaging about $4\frac{1}{2}$ tons per car, or a total of about 80 tons, and between one and $1\frac{1}{2}$ cars of stone. The rate of advance per day of three shifts is about 40 ft. One linear foot of $8\frac{1}{2}$-ft. heading will produce approximately 2 tons.

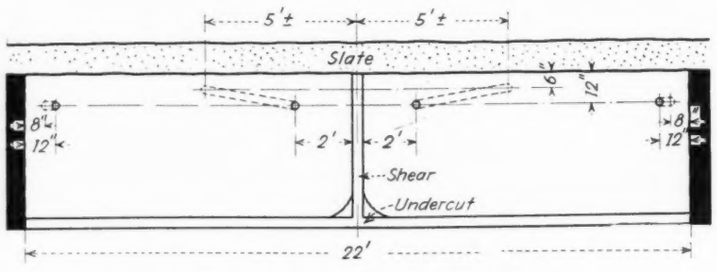


Fig. 4—Standard room-drilling plan

Equipment for a wide-work unit is substantially the same as for a narrow unit. A separate crew with truck does the drilling, however. The average tonnage produced by a wide-work crew in one shift is about 300, or 900 tons per day. After the necks are driven, a wide unit will complete a panel of twelve rooms with an average depth of 285 ft. from the room necks in fourteen days. From this the need for rapid entry development can readily be appreciated.

On the basis of past experience, the average number of rooms worked in producing 1,000 tons of coal is 32.8. For the same tonnage, an average of 21.1 yd. of entry must be driven and 18 yd. of room neck must be worked. The figure for room-neck yardage takes into account only standard-length rooms, and would be somewhat less if certain short rooms driven to recover pillars were included. And for every ton of coal an average of 0.02 car of stone must be loaded. A labor bogey is set for both the underground and the surface, and under this bogey, the output per man per shift, all men underground, is close to 13 tons on the average.

Cutting and loading machines are given a major greasing twice a week with a high-pressure grease gun mounted on a mobile truck, and enough oil and grease is kept with each machine to oil and grease cutting chains, etc., and refill the hydraulic storage tanks on the loaders as required during the working shifts.

To assure efficient operation of the mine, an extension is made every three months and blueprints are prepared showing the estimated advance and the various machine moves for the ensuing quarter. In advance of this move, the engineering department and the mine superintendent, John H. Richards at Willow Grove, make a thorough study of conditions and arrive at the proper method of attack. As examples of the way these schedules are set up, the various moves for a wide- and a narrow-work unit at Willow Grove in the first quarter of 1937 are summarized in Table III. Although unforeseen conditions may upset plans at times, there usually is but one or two days' difference between the forecasts and the actual performance records.

As it stands at present, Willow Grove No. 10 is a prime example of highly concentrated operation. Only 60 to 70 wide places are being worked, whereas approximately 500 wide places would be required if the same tonnage was being produced by hand-loading on one shift. One factor in this record is proper organization and supervision based on the employment of intelligent and progressive supervisors and alert, industrious, safety-minded and responsible men on the working units.

Table III—Working Schedule and Unit Moves for a Wide Unit and a Narrow Unit, First Quarter of 1937, Willow Grove Mine

Task	Days Required	To Be Completed
Narrow Unit E		
Driving 17-18 West, 19 North Face	23	Jan. 15
Necking C-2 (wide)	7	Jan. 23
Necking C-3 (wide)	7	Feb. 1
Necking A-4 (wide)	7	Feb. 9
Driving 19-20 East 19 N. F.	33	March 19
Necking A-5 (wide)	7	March 27
Driving 19-20 East 19 N. F.	4	April 1
Wide Unit A		
A-1 section	15	Jan. 16 *
A-2 section	30	Feb. 20
A-3 section	15	March 10
A-4 section	15	March 27
A-5 section	4†	April 1

* Started Dec. 29, 1936, upon completion of A section, nine days. † In first quarter.

Note: In the section devoted to the schedule for Narrow Work Unit E, "Necking C-2," for example, means preparing room necks for C-2 wide-work loading unit.

CONVEYOR MINING

+ Overcomes Competitive Handicaps

In Thin-Vein Excelsior District

By DEGEN BOYD

President, Excelsior Coal Corporation
Greenwood, Ark.

COMPETITION, which cost Arkansas most of its markets for steam coal, compelled operators in the Excelsior district, in the western part of the State, to turn to the harder, thinner beds to hold a place in the domestic trade. But here we were faced with the bugaboo of adverse natural conditions entailing mining costs much higher than in the thicker seams. Room-and-pillar systems failed to overcome these handicaps. So we turned to longface conveyor mining. Results of more than two years' operation under that method have shown these decided advantages over old room-and-pillar systems using wide rooms:

1. Concentrates our operation in small sections, enabling us to load larger tonnages.

2. Enables us to get 100 per cent extraction of the vein with the exception of our main slope pillars and thereby prolongs the life of our mine.

3. Simplifies the ventilation of a gaseous vein.

4. Reduces our production cost.

Today there are approximately 25 conveyor units of this type working in the Excelsior field and additional installations are planned for the present season. The Paris field, 40 miles east, is working about 50 such

units. This record, I submit, proves that the system described in this article is highly successful in working the thin-vein fields of Arkansas.

Coal has been mined from the thick beds of the Hartshorne seam in western Arkansas for over forty years. Although coal from this section is semi-bituminous in character, it is known in our trade territory in the North as semi-anthracite, being practically smokeless. In the early days of the industry practically all the coal produced was sold for railroad and general industrial consumption. Very little of the output was screened and that little was simply passed over a gravity bar screen. The thin veins were left undeveloped during this period because they could not be worked at costs which would permit them to compete in the steam markets with the mines in the thicker coal.

Early in the '20s, however, great quantities of oil and gas were discovered in the Mid-Continent field and throughout the Southwest. As a result of the competition which followed, over 75 per cent of our steam business was taken from us. We then began to look to the purely domestic markets of the Middle West for business to replace in part, at least, the tonnage we had lost to oil and gas. Coal from our thick veins, while excellent quality, was too soft to ship into Northern domestic markets because most of them demanded a coal properly prepared and sized at the mine and one which would arrive at destination with a small amount of degradation.

The coal from our thin veins—24 to 36 in. thick—was of a harder structure and was generally better in quality than the thick beds. But heavily pitching veins, water, bad roof conditions and gas in the vein presented many problems which had to be overcome before we could get any appreciable tonnage at a fair competitive cost from a mine in this thin coal. The old fashioned room-and-pillar system used in thick-vein operation proved unsuccessful except for a small mine. Better success was had with a room-and-pillar system using panels driven down the pitch and rooms driven wide along the strike of the vein. However, this method did not solve the problem and did not bring the results desired. Under both systems, coal was undercut by modern shortwall mining machines and loaded into small cars by hand.

Next, a light-weight, rather inexpensive face conveyor was developed. The goal here was 100 per cent extraction with the work concentrated in small sections so that the mine could produce coal in larger quantities at a cost which would enable it to compete with the fields in our neighboring States. Much experimenting was done in this work by our company, and out of this grew the system which we now use in our operations in the Excelsior field. This field is in the western part of the State about 18 miles south of Fort Smith. The Hartshorne seam, which is the one mined, outcrops in this valley and dips South about 9 deg. The coal averages about 30 in. in thickness; roof near the outcrop is very bad, getting better as the depth increases.

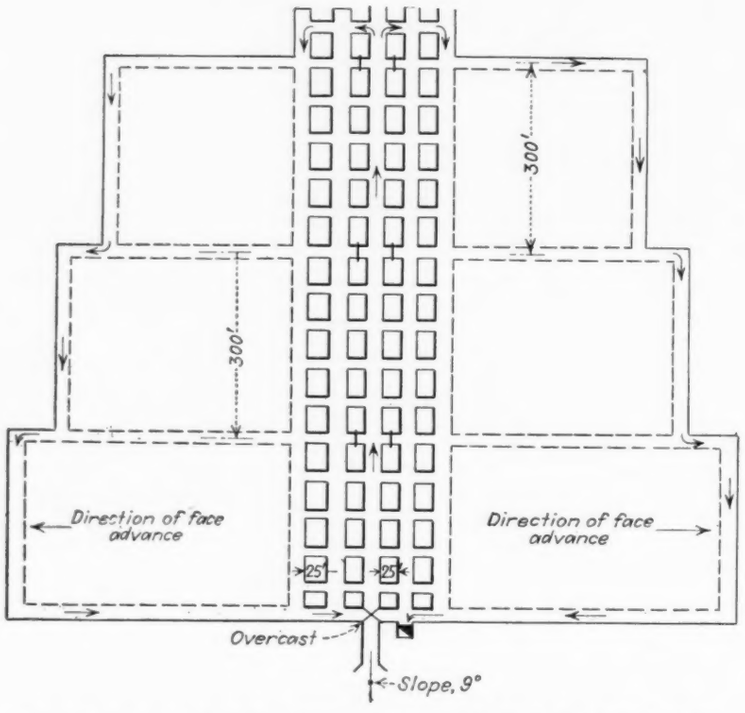


Fig. 1—General plan of development, with walls being driven out from each side of the main slope.

Fig. 1 is a plan of development of the mine, using the longface-conveyor method of mining to be described. The simplicity of this plan is easily seen from the sketch. Some operations do not leave the second set of chain pillars on the slope between the wall and the return aircourse but we have found that this protection is needed as we advance deeper with our workings. Our cover is now from 400 to 450 ft. and this additional protection is necessary at this point. In some cases our faces close, due to roof pressure, after a wall has been worked to the boundary; by having this added protection we have an auxiliary return aircourse, which is necessary because of the amount of gas present.

Units Average Over 100 Tons

In each of our two mines we have four conveyor units in operation. These units average over 100 tons daily each, depending upon the thickness of the coal, which varies from 28 to 36 in. This gives us a daily output of from 400 to 500 tons, which is a very practical tonnage for a mine in this field. With our production from these four units we can regulate our output in each mine to our ability to market the coal. Our operating season generally begins early in July and we operate two conveyor units, starting the remaining units as our seasonal demand increases. Our season generally ends early in March, the mines then remaining idle until the season begins again in July.

Fig. 2 is a sketch showing the plan of conveyor wall and also the entry, or roadhead, as it is commonly called. An average crew for a 300- to 350-ft. face consists of one unit foreman, or wall boss; two chunkers on the entry, who operate the conveyor and load cars; ten to fifteen loaders (the number varies with the thickness of the coal and the length of face); two machine men; one mucker behind the machine; one

hoistman and three entrymen. In addition to this crew we have a regular timbering crew which works at night and takes care of necessary entry timbering and other timbering incident to the operation of the mine as a whole.

With this crew the previously mentioned tonnage per seven-hour shift is produced. We load coal but one shift in each 24 hours. The machine crew cuts at night and the entry crew that drives the entry and brushes the bottom also works then. Since our hoist for the unit is located near the slope and since a complete main slope trip is handled to the conveyor at one time it is necessary that the entry, or roadhead, be kept ahead of the longface in order that the entire trip of empty cars may be pulled under the loading head of the conveyor and then dropped out toward the slope by gravity as they are loaded. A sheave is located in the face of the entry, or roadhead, to permit the trip to be handled in this manner. Using a shortwall machine with a 6-ft. cutter bar in the entry, or roadhead, we are able to keep ahead with this entry development, as only a 4-ft. cutter bar is used on the longwall machine which undercuts the wall.

As the machine men cut at night, the coal is ready to be loaded when our day crew, composed of the unit foreman, loaders and chunkers, reaches the face. No shooting is necessary, as the coal drops down back of the mining machine as it is undercut, due to the roof pressure. We do have to shoot the coal down when beginning a new wall, but after several complete cuts are removed the coal begins to break without shooting.

Ten Cars Make Up Trip

The loaders place the coal on the chain conveyor and it is loaded into the mine cars at the entry on the low side of the wall. When one trip consisting of ten 1½-ton cars is loaded it is dropped out by gravity to the main slope parting. While this trip is being changed, which may take several minutes if the entry is advanced any distance from the main slope, the conveyor is stopped, but none of the men is idle because they can be breaking their coal and getting it ready to load on the conveyor or they can be setting props along that portion of the face already cleaned up.

Our starting time at the face is 7:30 a.m.; under normal conditions the face is cleaned of its coal by not later than 1:00 p.m. When the face is clean of coal the crew starts to move the conveyor. Props have already been set along the face where necessary and one row has been set 3 ft. from the face of the coal. The crew then proceeds to move the conveyor forward against these latter props, which have been set uniformly and serve as a guide for placing the conveyor pans.

Being light, the conveyor is easily moved after being taken apart to permit moving without disturbing the timber already set. Since the pans, which are 6 ft. long, are not bolted together, moving them is a comparatively easy task. The loading head, containing the drive motor and the speed reducer, is somewhat heavier and requires a set of rollers or a pair of pull jacks to facilitate its moving. Each loader along the face is responsible for moving forward his section of the conveyor and reassembling the pans and the conveyor chain, which is standard-sized detachable conveyor chain. Each day after the face is cleaned up the conveyor is moved forward the distance of the face advance, or 4 ft.

When the conveyor is moved into its new position there is a 3-ft. space between the props on the inside of the conveyor pans and the face, providing sufficient room for the longwall mining machine to pass along the face without knocking out and resetting any of the props set along the conveyor. The machine cuts down the face one night and back up the next. As the machine cuts along the face the machine helper sets any additional props that are necessary. Moving the conveyor under normal conditions requires an average of 45 minutes.

When the moving of the conveyor has been completed the next operation is sending props, cribbing, headblocks and other necessary timbers up the wall. The conveyor drives are easily reversible with a double-throw switch and the different sorts of timbers are sent up the face on the conveyor. Each loader takes off the necessary timbers as they pass his working space. The numbers and the length of the various timbers have previously been determined by the unit foreman, who has taken a list of each man's requirements and has ordered timbers from the outside accordingly. These timbers then are placed by the loaders back of the conveyor, where they will be available for the next

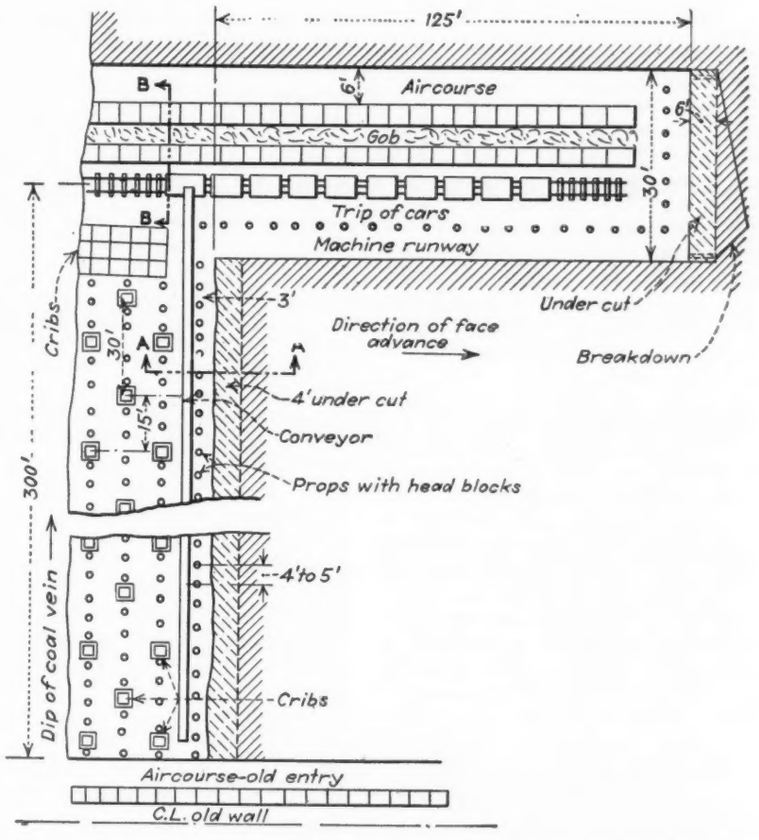


Fig. 2—Plan of conveyor wall and entry, or roadhead, on which trips are loaded by the conveyor.

day's operation. When this is done the day crew is finished and the face is ready for the machine crew.

Our mine operates on a 7-hour-day basis and unless unforeseen delays or extremely bad roof conditions are encountered, the wall is cleaned of its coal, the conveyor moved and the timbers are sent up the face well within this period.

Fig. 2 also shows the method of timbering the face. It must be remembered that our roof is not a longwall roof in the strict sense of the word but is a roof that must be controlled in order to keep it from breaking off at the face of the coal. This control is effected by the proper use of timbers. Although our timber costs have increased greatly over those on room-and-pillar systems, this disadvantage is offset by the other decided advantages of this system over the old.

Square Cribs Hold Roof

In our operation we have no refuse to fill the gob behind the conveyor, since we normally have no drawslate and since our cutting is done in the coal, due to the very hard nature of our bottom rock. We have found, after considerable experimenting, that square cribs of pine timber set at regular intervals along the face control the roof breaks better than any other method of timbering that we have tried. These cribs are, of course, in addition to the regular straight props of pine which we set along the face as the coal is loaded from a cut.

On either side of our entry, or roadhead, we have to set cribs in order that our haulage road and our aircourse be protected. In order to fully protect this area we standardized, after many experiments, on three rows of cribs on the upper side of our roadway and two rows below the roadway, in addition to the bottom brushing, most of which is placed as a packwall between the cribs on the lower side of the haulage road, leaving a 6-ft.-wide aircourse on the extreme lower side of the haulage road.

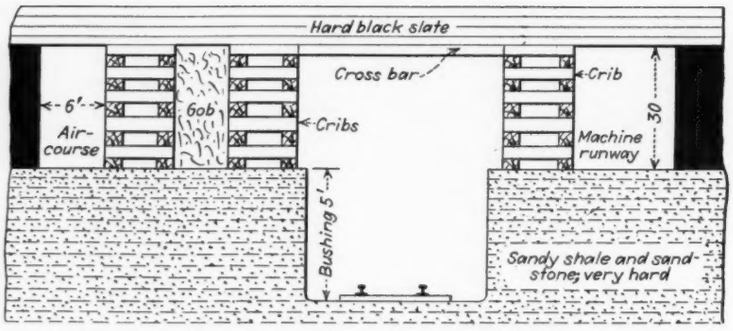


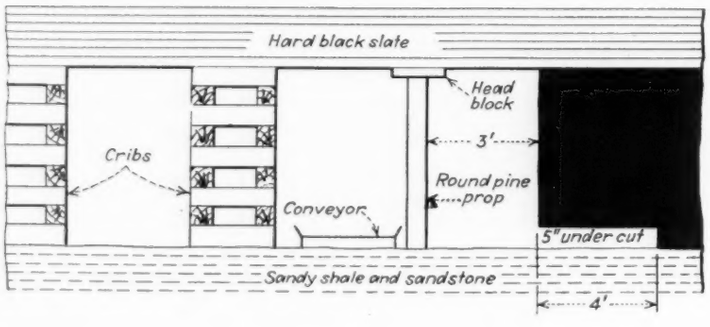
Fig. 4—Section of entry, or roadbed (B-B, Fig. 3), showing bottom litfing, cribbing and packwall, as well as aircourse position.

Along the wall we set approximately one crib per man each day, or one crib approximately every 30 ft. At times we put these cribs double this thickness, depending upon the condition of the roof. In cases we found that we could put the cribs farthest apart on the upper and lower ends of the wall and closer toward the middle, as the roof had a decided tendency to override the cribs and props at approximately the middle of the wall.

We get our roof breaks on the various walls approximately every ten to fifteen cuts. Timbering on the individual units depends partly on the local conditions of the top on the various walls. We have definitely concluded, however, that we must use cribs to control our roof properly and to allow our cycle of operation, and we have had no difficulty with roof control since beginning their systematic use. Unit foremen are charged with properly placing the timbers and cribs and learn within a very short while the proper method of handling their own individual units, even though we have standardized on certain timbering methods for the operation as a whole.

Crib timbers are of pine, sawed square on but two sides, and are 4 in. thick and 3 ft. long. Cribs are built square and are made tight against the roof with wedged cap pieces, which we purchase in bundles similar to wood shingles. These wedged cap pieces are about 1 in. thick at the large end and are 8 to 10 in. long. The loaders soon become very adept at building a crib quickly.

Fig. 3—Section of longwall (A-A, Fig. 3), showing position of conveyor, props, cribs and face of coal in relation to the worked-out area.



Props Have Headblocks

Our straight round props also are pine, as this material has a tendency to squeeze instead of breaking off under roof pressure. They are 5 to 8 in. in diameter and we purchase them in lengths of 28 to 36 in. to fit the different vein thicknesses encountered and to eliminate cutting timbers to the proper length in the mine. These props are set with a headblock over them. The block is a flat piece of soft pine, 12 to 18 in. long and 2 to 4 in. thick, sawed square on two sides only. The headblock takes great weight and the props squeeze into the block as the face moves away from the prop. The latter does not reach the breaking point until the face has advanced a sufficient distance ahead of it. Straight props are set at whatever distance apart the roof condition demands, but in normal work this is about 5 ft. They are set uniformly along the face and each loader is responsible for timbering his working space along the wall.

Since our coal vein lies between two strata of hard rock, with the bottom rock considerably harder than the top, we have considerably more timbering to do than if our bottom was soft enough to allow the props to sink into it as the area was worked out and the roof pressure became greater. The problem of roof control also would be easier to handle if we had sufficient waste and draw rock to fill our gob in-

stead of having to depend entirely on timbers for this roof control.

In addition to the cribbing and timbering methods described we use pine crossbars across our haulage roads on the entry to take care of any rock that might become loose. As the roof pressure becomes greater as the entry advances we sometimes have to go back and replace these crossbars. This work is done by our regular mine timbering crew, although we have had very little difficulty with loose rock on our haulage roads since beginning this system. Each operation in the longwall field has its individual timbering problems and ours has been solved by the timbering methods outlined.

Fig. 3 shows a section, *A-A,* of the longwall. From this sketch can be seen the relative positions of the conveyor, the straight timbers, the cribbing and the worked-out area from the face of the coal. At times, when a roof break is in progress, to further protect our working face, we set the straight props either double or triple, alongside each other, thereby adding strength to them at the necessary points.

Fig. 4 is a section, *B-B,* of the entry, or roadhead, showing the amount of bottom lifted, part of which is used as packwall below the entry and part of which has to be loaded and hauled to the outside for disposal. The positions of the cribs along the roadway and the method of gobbing the brushing rock on the lower side of the roadway also are shown, along with the position of the aircourse on the extreme lower side of the entry, or roadhead.

No cribs are set along the upper side of the roadway as the entry advances, that timbering being taken care of for the time with straight round pine props. If cribs were set along this upper side as the entry advanced they would interfere with moving the conveyor forward each day. Three cribs are set each day on the upper side of the entry after the conveyor has been moved, to protect the entry and haulage road as roof breaks occur and roof pressure becomes great in the worked-out area.

The bottom is extremely hard and a heavy air drill is necessary for drilling the bottom holes. We drill the holes to a depth of 6 ft., the length of the cut taken out of the entry, and we have found that this depth of hole gives us a better lift with the 40 per cent gelatin dynamite used for shooting this brushing. Three holes, one on each side and one in the middle, are drilled. One-inch drill steel is used because $\frac{7}{8}$-in. steel breaks too readily in the hard rock. Detachable drill bits have proved most practical for our work.

[SECOND OF TWO ARTICLES]

LIGHTNING DANGERS

+ To Coal-Mine Distribution Systems Minimized by Protective Devices

By C. T. PEARCE
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THE FUNCTION of lightning protection, as explained in the preceding issue of *Coal Age,* is not only to drain off the lightning surge, so that the peak will not be so high, but also to reduce the steepness of the voltage wave front to ease the stress in the insulation of the electrical apparatus. An arrester is used to safeguard the insulation of electrical equipment by reducing the harmful over-voltage and thus preventing it from breaking through or over the insulation to the earth. Good grounding, as explained in the previous article, is essential.

Lightning protection can be considered under the following general headings:

1. High- and medium-voltage transmission lines.
2. Low-voltage transmission lines.
3. Distribution and power-transformer equipment.
4. Alternating-current rotating equipment.
5. Direct-current circuits.
6. Cables.

High- and Medium-Voltage Transmission Lines—Complete protection can be obtained in transmission lines by the liberal use of lightning arresters, properly installed. This, however, usually is too expensive for the results obtained, and if lightning arresters are used they are located only at vital points and those most subject to lightning disturbances. For important lines, arresters usually are supplemented by the use of properly designed overhead ground or shielding wires. However, counterpoise must be used in connection with ground wires if the soil conditions are not such as to give a low tower-footing impedance. A counterpoise consists of ground wires fanned out from the tower footing to obtain the equivalent of a common ground. Obviously this also is a very expensive method.

Depending upon the voltage and location, transmission-line protective devices may consist of the following:

1. Distribution-type arrester.
2. Station-type arrester.
3. De-ion tube protector.

The most commonly used arrester

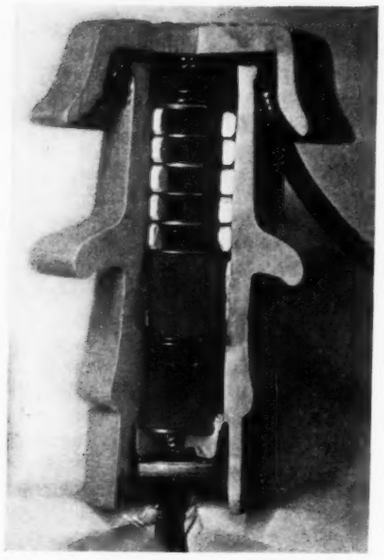


Fig. 3—Cutaway view of a 6,000-volt distribution arrester. The series gaps for breakdown voltage are in the upper portion, the porous blocks for valving off the current are in the lower portion, and the dropout is indicated at the bottom.

is the distribution type for moderate-voltage alternating-current circuits (Fig. 3). It has a series of gaps and porous blocks, as required by the voltage. The ground wire is connected to the drop-out section to indicate overstress or failure of the arrester. The whole is incased in a weatherproof water-tight porcelain housing, and arranged for bracket mounting on the pole or pole arm. This type is used for general distribution lines and particularly in the neighborhood of distribution transformers.

Station-type arresters are similar in construction but of larger size and higher voltage and current ratings. They also have a slightly better protective ratio. They are used on the higher voltage lines and in such cases where transformers and other station apparatus are to be protected. In both types the gap setting determines the breakdown voltage. After the arc is established, the porous blocks carry the energy of the high-voltage surge to ground. The blocks and gaps then together extinguish the power follow current at a voltage higher than any normal operating value.

Use of De-ion protectors for transmission-line installations is considerably cheaper than lightning arresters, although they do not possess as good a characteristic. They have a protective ratio in the order of 6 to 1, which generally is satisfactory for transmission-line insulation, but not for the usual protection of high-voltage transformers or for rotating machinery. They have characteristics of valving off the power follow current which makes them superior to the ordinary gap where the small power follow current either causes an outage or requires a series fuse to be replaced. This type of protector is satisfactory for use only on grounded systems in order to insure obtaining sufficient power follow current to volatilize the tube and give the valving-off action at the first current zero. De-ion protectors consist of a small-bore fiber tube with metal electrodes at each end. This is housed in a larger tube to which are attached the mounting bracket and arcing horn or terminal.

Low-Voltage Transmission Lines—In low-voltage transmission lines, ground wires are not of much value for voltages of approximately 15 kv. and below, since the voltages induced in the transmission line from lightning striking in the near proximity will often flash over the line insulation used for these lower voltage classes. Lightning arresters or De-ion tubes are the usual solution. At lower voltages, the cost of lightning arresters is not such a deterrent to their liberal use in exposed locations. The protective equipment used is similar to that described for high-voltage transmission lines.

Transformer Equipment—Lightning arresters installed occasionally along the lines for distribution transformers are frequently considered adequate protection. This may be true for certain urban localities, but is certainly not sufficient for mountainous or rural districts. Unless protection is provided at or near the transformer, severe lightning stresses may be set up.

Stresses in the insulation of a transformer from lightning are set up between the primary and the core or tank, between the secondary and core or tank, and between the primary and the secondary windings. The old method of protection for distribution transformers was to install arresters on the high side and possibly ground the secondary neutral. It has been found that this is not adequate, particularly if the grounding was faulty. The present method, therefore, is to connect the arresters to ground and also to the transformer tank through a special protective gap. The neutral of the low-voltage winding likewise is connected to ground and to the tank through another protective gap. This is the so-called three-point protection (Fig. 4).

In operation when a surge enters over the primary it is discharged to ground. This may raise the primary winding surge potential considerably above the tank, in which case the gap *C* (Fig. 4) will discharge. In case the voltage between the tank and secondary exceeds a safe value, gap *D* will discharge. Thus, the surge potential of both windings is limited with respect to the tank, which also limits the voltage between the two windings. It should be noted that the tank gaps *C* and *D* may be

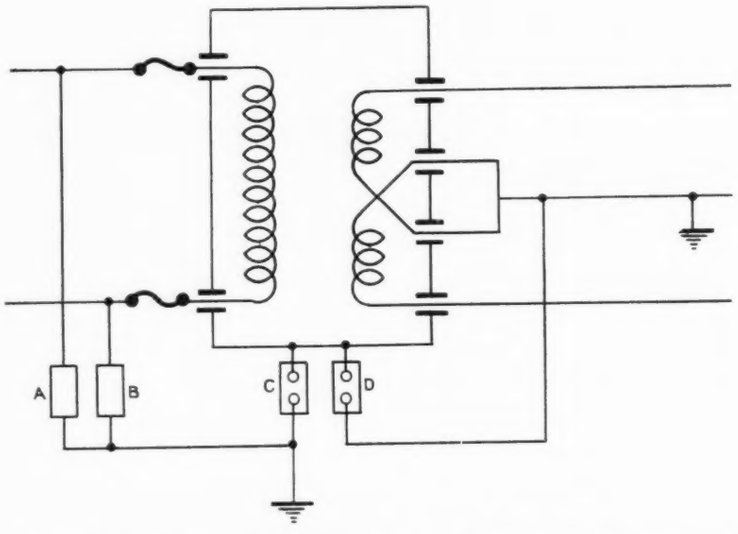


Fig. 4—Three-point protection applied to a distribution transformer. *A* and *B* are arresters, *C* and *D* are protective gaps. Frequently *C* and *D* can be omitted and a common tank and ground used.

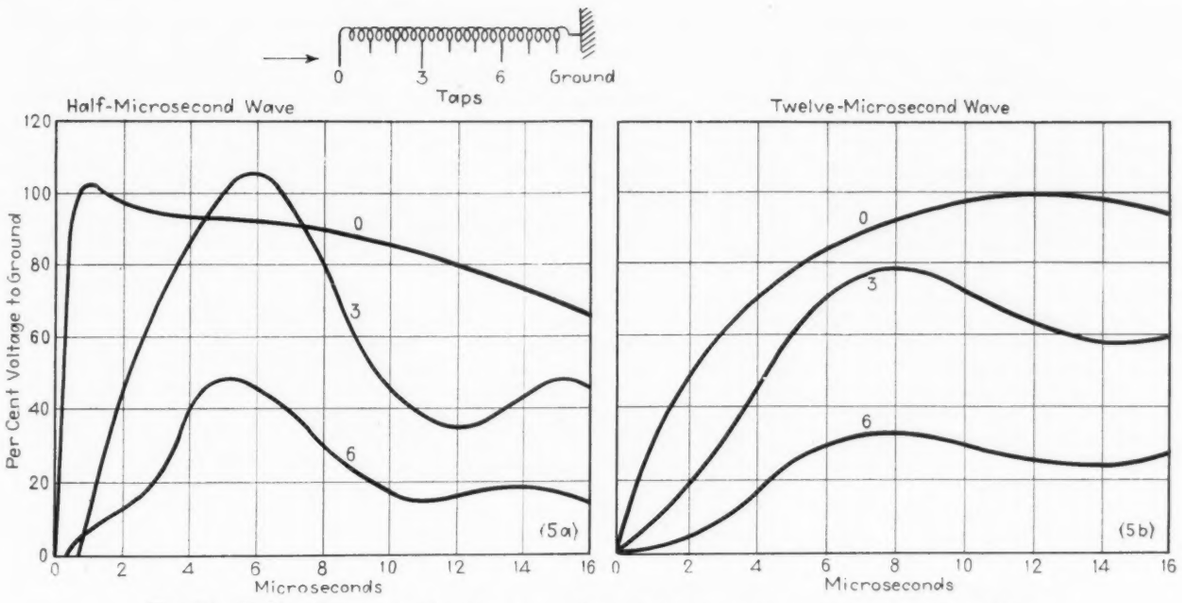


Fig. 5A (Left)—Curves showing how the voltage builds up with time, in generator windings at designated taps, from a surge wave similar to that of Fig 1. Oscillations shown by disproportionate voltage on taps 3 and 6, particularly on short wave, result in stresses between turns. Fig. 5B (Right)—Effect of surge protection for rotating machines in reducing the wave front and consequently the stresses in the generator windings.

omitted if grounded tanks are desired.

Transformers as they are now built are equipped with insulation which is coordinated with "rod gaps" for traveling waves of moderate steepness. Older transformers often have lower impulse strengths. These rod gaps usually are placed on the bushings, but may be mounted separately at any convenient adjacent location. Operation of the rod gaps, of course, gives an outage, but this is an inexpensive replacement. To take care of steep wave fronts resulting from near-by strokes and to avoid outages it is recommended that lightning arresters always be installed at the apparatus. The rod gap is in parallel with the arrester and provides back-up protection in case the arrester is out of service or not functioning properly.

The above is on the basis of taking care of traveling waves, which constitutes the great majority of surges. In case protection is desired against direct strokes right at the apparatus, more elaborate methods must be used. Distribution transformers can now be obtained which are equipped with self-contained De-ion gaps and protective gaps, and which are coordinated with the transformer insulation in such a manner as to make them completely self-protecting against direct strokes. Existing distribution transformers may be equipped with De-ion protectors, together with protective gaps, to endow them with this three-point protection against lightning, provided, of course, the surge level of their insulation is sufficiently high.

Although not applying directly to the subject, it is of interest that this type of transformer can be obtained also with primary short-circuit protection, together with overload protection by a breaker in the secondary, all incorporated in the transformer tank. The breaker even functions to indicate, by a red light, when the transformer has reached the dangerous temperature range. These are designated as completely self-protected transformers.

On high-voltage power transformers, the De-ion gap does not have a sufficiently low protective ratio to protect the insulation. Protection against direct strokes may be obtained by extending overhead ground wires out from the substation for a couple of spans. In other words, the major difference between protection against traveling waves and against direct strokes is the use of the ground wire for the former. In either case, it is often desirable to augment the lightning arrester with a De-ion gap located a span or so away from the substation. This gap intercepts the surge first and it relieves the duty on the lightning arrester and, in addition, improves its protective ratio to some extent.

Alternating-Current Rotating Equipment—Any equipment with multi-turn circuits presents the known fact that, when a surge is impressed upon it, the voltage will not distribute evenly throughout the circuit but will tend to concentrate across the first few turns. The extent to which this will take place will depend on the number and arrangement of turns and the steepness of the front of the surge. In the case of transformers, this usually is taken care of by putting extra insulation on the line end turns, commonly known as "padding," but with rotating machinery the space for insulation in the slot is necessarily limited so that it is not feasible to overinsulate any of the turns with respect to the remainder of the winding (Fig. 5).

Where the motor or generator is connected through a transformer to the overhead line, no lightning protection is required for the machine itself, provided, of course, that the two are in such close proximity that lightning disturbances cannot affect the interconnecting lines directly. If the transformer is properly protected its arrester will reduce the magnitude of the incoming surge and the transformer winding will slope the wave front so that it will not harm the rotating machine.

Where rotating equipment is directly connected to an overhead line which is exposed to surges, special protection is required. The problem here differs from transformer protection in that account must be taken of the steepness of the wave front as

well as its magnitude. A lightning arrester at the machine terminals limits the magnitude of the surge voltage but not its steepness.

This special protection for rotating machines usually takes the form of the tuned circuit, comprising inductance and capacitance to slope the wave front of the incoming surge before it reaches the machine. In addition a special line-type arrester is placed in parallel with the capacitor on each phase right at the machine. The special arrester, the capacitor, and the machine frame are connected to a common ground. The special arrester has a protective ratio of approximately 2 to 1 to limit the magnitude of the surges impressed upon the machine winding. The use of a standard line-type arrester approximately 1,500 ft. away from the machine also is recommended. The theory of this arrangement is that the surge impedance of the line gives the necessary reactance which, combined with the capacitor, slopes the wave so that the surge will not pile up on the end windings of the machine.

More adequate protection may be obtained by utilizing a lumped reactance rather than relying upon the line impedance. The line arrester is brought to within close proximity to the machine and a choke coil installed between the line arrester and the machine arrester. This permits the line arrester to be connected to the same ground as the machine arresters, capacitors, and machine frame. While this arrangement (Fig. 6) costs more than the one previously described, the additional cost usually is warranted when considered in relation to the machine investment. The inductance of the air-choke coil is quite low and has no appreciable effect on the line regulation.

Direct Current Circuits—In the application of protection to direct-current equipment there are two types of arresters. One uses a multiple-gap disk, while the other utilizes the capacitor principle. Of the two, the latter is superior, although somewhat more expensive than the former. The multiple-gap disk is available up to 750 volts and the condenser type is applicable up to 3,900-volt circuits. The condenser-type arrester has the lower voltage ratio. It is, therefore, particularly applicable to direct-current machines or those with weakened insulation.

Cables—A cable connected to an overhead line introduces a change in surge impedance which may have the effect of reducing the traveling wave voltage, but under certain conditions this may build up again at the machine by reflection to a dangerous value for the machine. In cases where the cable leads to a piece of apparatus, adequate cable protection usually is obtained by the apparatus arrester. However, where the cable insulation is weak, it may be desirable also to install an arrester at the junction to the overhead line, grounding it to the cable sheath.

Rotating machines connected at the end of a cable require the same protection as previously described except that with a cable of some 400 ft. or more it is not so essential to use the choke coil, as the cable itself has a tendency to reduce the steepness of the surge in the circuit.

Selecting arresters of a high voltage rating, to reduce arrester failures because of expected high peak voltages, may increase apparatus failures due to the loss of protective efficiency, since the transient voltage which an arrester will permit across its line and ground terminals is a function of its rating. The risk of an arrester failure from dynamic overvoltage must be balanced against the reduced voltage protection to apparatus furnished by an arrester of increased rating.

Probably the most fundamental consideration in choosing lightning protection is that of economics. There usually is a rather wide choice in the degree of lightning protection which can be installed. In some cases the ultimate is justified but oftentimes, particularly in the case of line protection, a compromise works out better when the cost of the protection in terms of carrying charges is balanced against the probable cost of outages resulting from lightning. In this respect lightning protection can be likened to insurance.

In conclusion, it should be pointed out that the theory of lightning protection is to a certain extent still in a state of development. Certain details of the above recommendations may or may not be substantiated by later investigations. This article is an attempt to give a brief summary of the phenomena of surges, their effect, and types of protection that are available at the present time. It is hoped and expected that further research will result in improved and less expensive types of protection.

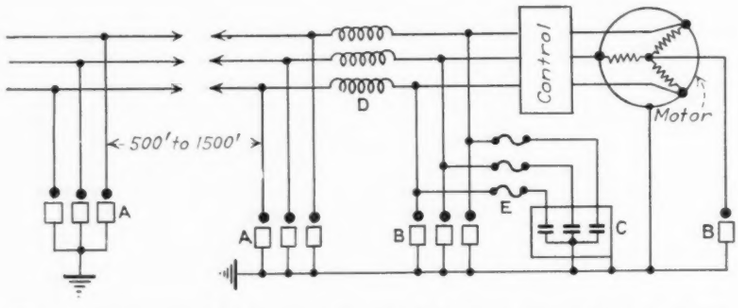


Fig. 6—Surge-protection measures suggested for rotating machines to secure most reliable results. *A*, standard arresters; *B*, special low-ratio arresters; *C*, capacitors; *D*, choke coils; *E*, fuse cutouts.

ANALYZING VARIABLES

+ Which Can Make or Break Program Of Underground Mechanization

By WALTER M. DAKE
Research Manager, Coal Age

NET COST SAVINGS for mechanical-loader installations can be accurately predetermined by balancing the effects of physical mining conditions against the operating functions and efficiencies of all equipment installed. Many early failures in mechanization, and the greatest proportion of the only partially successful present-day installations, are directly attributable to a lack of fundamental data upon which to base conclusions or to the incorrect planning of operating methods in relation to types of equipment and man power employed. Careful analysis of each detail in the general plan of operation is necessary to assure maximum realization from the investment, as any one or any combination of two or more of 35 variables will affect the percentage of net profit.

Changes in procedure invariably provoke criticisms from mine organizations—and the first variable in mechanization is the all-important mental attitude of management and men toward machines. Thorough knowledge by key men of principles involved and the selection of crews who are willing to expend every effort to modify or change former methods and practices to fit the machines, within limits of welfare and safety, are essential to complete success with mechanical loading.

Cooperation a Necessity

Passive resistance to installation, or biased interpretation of operating facts and figures, can be overcome and a spirit of complete cooperation achieved only by constant and frank discussion of all detrimental or beneficial factors entering into each installation. Open meetings held at stated intervals by management and men will tend to eliminate prejudices and false precedents as incalculable deterrents to lowest f.o.b. mine costs.

Second in importance are the physical characteristics of the coal seam. These must be considered as a limiting group of variables determining the type, size and capacity of equipment to be used. The ventilating and safety cost of mechanical loading is slightly affected by a gaseous or non-gaseous classification, while the use of permissible rather than open-type equipment involves a higher unit cost. Increased ventilation cost growing out of greater volumes and velocities of air in working places should be expected, as well as added costs for face sprinkling to increase visibility and rock-dusting to eliminate hazards.

Seam Must Be Studied

Minimum, average and maximum thickness of coal and pitch of seam must be carefully considered for the purpose of correctly selecting that size of equipment which will give adequate clearances under all working conditions and also have sufficient power to handle all loads at top speed on adverse gradients. The character and texture of coal affect not only power and type of drilling equipment, number and spacing of holes, quantity of detonators and explosive consumed, but also the manner in which prepared faces "load out" mechanically. Inherent size and shape of block or slab produced, as well as the percentage of coarse or fine coal desired for specific markets, directly affect the choice of mechanical-loader type, capacity per minute, and power required per loading unit.

Depth of cover overlying the coal and the character of the roof limit the width of working places and determine the method of mining employed. These important factors also directly affect mechanical loading from the concentration standpoint of panel dimensions, width and length of entries; width, depth and spacing of rooms and pillars, or the use of longwall or longface mining.

Floor Type Affects Plans

Character of floor also must be considered. Soft fireclay may absorb sufficient moisture to bog down machines and track, or scale off and mix with the coal while it is being loaded. Hard floors reduce the pitch on which caterpillar machines can maneuver, and increase the cost of holding temporary rail in position for track-mounted cutting and loading machines.

The use of mechanical loaders of varying design and size is not materially affected by timbering, as systems are now employed which, even under adverse conditions, afford adequate protection and safety while assuring sufficient clearance for all loading and moving operations. All types of loaders must be studied carefully, however, in relation to advancing or retreating pillaring and longface mining methods, as mechanical gathering of coal from various points of attack can be slow or rapid, with consequent high or low cost for these particular opera-

tions. All major groupings of physical mining conditions may pose one or more specific problems bearing directly on mechanical-loader application, but, if each such group is analyzed carefully, the special problems will not be overlooked in the final calculations.

Though the relationship of equipment to physical mining conditions is of great importance, the individual operating cycle of all production units in relation to one another is equally important and constitutes the third group of variables affecting economic results. As power requirements are increased by the installation of mechanical loading, the kind of power used, volume available and the efficiency of the distribution system have a direct influence on mechanical-loader applications. Motors designed for 250-volt loads can operate at 200 volts, but the efficiency of the unit is impaired and high electrical maintenance costs invariably result. Adequate power must be constantly available and an average increase in consumption of 1 kw.-hr. per ton of production must be figured in changing from hand to complete mechanical loading.

Capacity Comparisons Vital

The various kinds of equipment entering into the mechanical production and handling of coal from the working face to surface preparation plant and operating cycle of each must be compared under different capacities before conclusions can be reached as to final mechanical-loader output per shift and cost per ton.

Cutting machines usually are manned by a crew of two, and labor cost under local contract or day rates is in exact ratio to tonnage cut. However, cutting and traveling speeds and the length of cutter bar in relation to the thickness of seam and width of working place determine the tonnage per cut and the number of cuts per shift. For example, in a mine opened in a 60-in. seam by room-and-pillar methods, with roof conditions allowing 15-ft. entries and 30-ft. rooms, the yield per foot depth of cut across the entry width will be approximately 3 tons; rooms, 6 tons—or 18 and 36 tons, respectively, for a 6-ft. undercut; 21 and 42 tons for a 7-ft. undercut; 24 and 48 tons for 8-ft., and 27 and 54 tons for a 9-ft. undercut.

A shortwall machine with an 8-ft. cutter bar, averaging 240 tons per shift, will cut five room faces, while a track-mounted cutter with the same length bar might easily cut ten room faces, or 480 tons per shift, with exactly the same number of men on the crew. Using the shortwall-type cutter at 240 tons per shift with a loading machine cleaning up an average of ten rooms per shift, the labor cost of cutting on a day rate would be exactly double the cost with high-speed track-mounted units. On the other hand, the cost would be exactly the same on a tonnage rate. If the coal were 3 ft. thick instead of 5 ft., the same shortwall machine with a 6-ft. bar would exactly balance a mechanical loader averaging 213 tons from ten places per shift in 30-ft.-wide rooms.

Must Watch Unbalancing

Unbalancing of cutting and loading units occurs when cutter capacity is below the average loader production per shift or when a high-speed cutting unit is assigned to a territory where loading-machine average is below the proved capacity of the cutter. In the first case, overtime is required to keep prepared coal ahead of the loader. In the second case, cost of this operation is increased by mechanization. Bottom, center and top cutting methods affect drilling and blasting practices as well as mechanical-loading results. The additional cost of removing banded impurities by cutting, where it can be accomplished satisfactorily, may save many dollars of investment in additional surface picking or cleaning facilities.

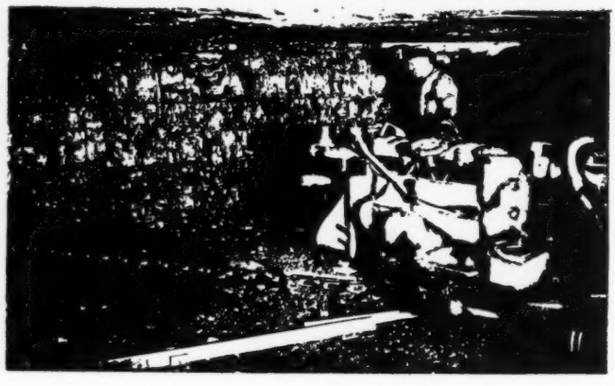
Hand, hand-held power or high-speed mounted drilling must be adapted to both cutting and mechanical-loading cycles to obtain the lowest cost for this phase of operation. Equipment for drilling a small number of holes to prepare faces for low-capacity loading machines in thin seams or under adverse mining conditions may call for a two-man crew, while double or triple that number of men and drilling units must be used ahead of high-production loaders in thick seams. On the other hand, one heavy-duty mobile-type track-mounted drill may be of such capacity or drilling and blasting conditions may be so favorable that it can follow eight shortwall cutters in preparing faces for four mechanical-loader units.

The cost of detonators and explosives consumed per ton of mine production can be accurately determined from existing records and close estimates made for mechanical loading. Usual practice calls for more shotholes per face and less explosive per hole to distribute the breaking force more evenly and produce a completely loosened "fall" without unduly shattering the coal. The loose fall promotes faster loading per minute, with consequent increase in places cleaned up per shift and lower costs per ton. On the other hand, light shots and "tight" falls, with a lower average tonnage per loader, may be advisable where market demands call for greater percentages of coarse coal.

Net Reduction the Thing

Mechanical-loading profits must be predicated on a net reduction in total costs and not on reductions only in certain phases of the operation. For example, overshooting may reduce face loading costs appreciably, while the increase in fine sizes of coal, with attendant reduction in sales realization, might result in net loss on mechanized operation when compared with former practice.

Tonnage produced per working face and concentration of places for economical output per unit crew under a specific mining condition determine the most economical capacity, size and type of mechanical loader. Development and wide work can be accomplished by all types of equipment, but it obviously is as impracticable to apply slow-speed, low-capacity units to production under



favorable high-seam conditions as it would be to attempt the utilization of high-speed heavy-duty machines under adverse physical conditions. The same capacity loader could not be applied as economically to double-entry development in a thin seam where shooting on the shift is prohibited as it could to developing five parallel headings in operations where blasting is permitted at any time.

Small tonnages from isolated sections of a mine can be profitably loaded mechanically if the number of men per crew, plus the additional productive power of the equipment itself, is properly balanced against all limiting physical conditions. This roughly expressed formula also applies to properties where adverse physical conditions impose a greater number of deadwork cycles, which in turn curtail available loading time.

From the standpoint of output per man employed, a production of 132 tons per shift in a slow-speed cycle of gang-work cutting, drilling, shooting, mechanical loading, trackwork and timbering by a six-man crew in thin coal, or under adverse mining conditions, approximates a high-speed cycle of operation with an eighteen-man crew producing 400 tons. The percentage of face-cost saving made by the small crew, however, probably will be greater than on the 400-ton output, due to higher rates applying to thin seams or the additional cost of deadwork under adverse mining conditions. *Tonnage produced per total employee—not the tonnage produced per mechanical-loader shift—determines the percentage reduction of total mine costs.*

Transportation and Output

The height, width, length and average capacity of pit cars serving the loaders, or the peak capacity of conveyors transporting the coal from machines to central car-loading points or, in some late installations, to the surface, considerably affect average tonnage per unit shift. Track arrangements for quick car changes behind loading machines, or the type of conveyors used for coal transportation in relation to their weight and the time needed for adding or taking off sections also partially affect tonnage produced per unit shift and men employed.

The number of pit cars available in relation to length of haul, the number of round trips which can be made per shift and the efficiency of dispatching loads and distributing empties are decided factors in economical mechanization at many mines. Inadequate motive power on main-line hauls also accounts for many time losses when mechanization is first installed at hand-loading operations.

Conveyor transportation of coal from working face to a central loading point has set aside limits imposed on production by small-capacity mine cars, while multiple conveyor installations for continuous movement of coal from the face to the surface have shown marked reductions in investment for transportation facilities in new mines.

Tipple and preparation-plant type, facilities available and capacity per hour must be figured in relation to any variation of the feed product due to mechanization. In a change from hand to mechanical loading, where banded impurities occur in the seam, it may be more economical to put a preparation crew to remove drawslate or slabby material underground or it may be advantageous to employ more pickers on the tipple for this purpose and load out the entire face. But in either case this cost must be deducted from the gross savings shown for mechanization. Increase in impurity content of coal going to wet- or dry-preparation plants may result in lower capacity per hour and consequently higher costs per ton or in investment in additional plant capacity to balance mine output.

The fourth group of variables affecting mechanical-loader savings consist of contract tonnage and day wage rates in relation to output per total employee, or the direct labor cost per ton of production. As labor approximates 60 per cent of the total f.o.b. mine costs, a detailed analysis of all operating phases must be made so that results under hand loading can be compared accurately with the expected results under mechanical loading. With more variations occurring in development and tonnage production than in any other part of the operation, costs should be segregated for each phase—from face to main-line parting and from parting to preparation plant—supplemented by average costs for mine maintenance, product sizing or treatment, engineering, management, general mine overhead, mine supplies and power.

★ ★

Mechanization Variables

1. **Attitude of men and management.**
2. **Operating organization efficiency.**
3. **Kind of mine—shaft, slope or drift.**
4. **Thickness of seam—minimum, maximum.**
5. **Character and texture of coal.**
6. **Pitch of seam.**
7. **Wet or dry operation.**
8. **Character of floor.**
9. **Character of roof.**
10. **Seam impurities—banded, inherent.**
11. **Depth of cover.**
12. **System of mining.**
13. **Panel dimensions.**
14. **Width of entries.**
15. **Width of rooms.**
16. **Longface or longwall.**
17. **Timbering systems.**
18. **Pillar extraction—advancing, retreating.**
19. **Surface cleaning facilities.**
20. **Power and distribution system—voltage.**
21. **Hoisting and transportation.**
22. **Motive power—condition and capacity.**
23. **Rail weights, gage and condition of track.**
24. **Conveyors—condition and capacity.**
25. **Average length of main haulage.**
26. **Average tonnage hauled per trip.**
27. **Type and capacity of cars.**
28. **Number and condition of cars on hand.**
29. **Dispatching system and efficiency.**
30. **Cutting methods and costs.**
31. **Drilling methods and costs.**
32. **Blasting methods and costs.**
33. **Loading methods and costs.**
34. **Yardage and deadwork costs.**
35. **Contract and day wage rates.**

Total-Cost Breakdown

Assuming a mine operated on the triple-main double-entry panel room-and-pillar system and producing 2,500 tons from 5-ft. coal by hand loading, the total cost may be broken down as follows: Face to main-line parting—cutting, 10c.; loading, 72c.; gathering, 5c.; deadwork, 4c.; timber and trackwork, 1½c.; supervision, ½c., or a total of 93c. per ton; parting to preparation plant (main-line haulage and hoisting), 2½c.; maintenance, 1c.; preparation, 5c; engineering, ½c.; management and general mine overhead (including royalties, taxes, compensation, insurance, etc.), 15c.; mine supplies, 19c.; power, 8c. This gives a total f.o.b. mine cost (excluding depreciation and depletion) of $1.44 per ton.

In the preliminary study on which the change from hand to mechanical loading was to be based, it was shown that the tipple was originally designed for 300 tons per hour but that it had been speeded up with the advent of the shorter working day

to screen 360 tons per hour. Another picking table and loading boom had been added and, with the very small quantities of impurities removed underground, preparation facilities were considered adequate with additional tipple labor of four men at $4.40 each per shift chargeable to mechanical loading.

Average haul from gathering partings to tipple was two miles, with two main-line locomotives making twelve round trips of about twenty cars per trip each shift at an average elapsed time of 30 minutes per round trip. There were 250 pit cars in use and the number dumped per shift averaged 463. The average capacity was 5.4 tons hand loaded and the turnover was slightly more than 1.8 times per shift. As reductions in car capacity resulting from mechanization generally range from 7 to 15 per cent, due to the speed of loading and the lack of time for coal to settle in the car, the level-full capacity of 4.8 tons—a theoretical reduction of 11 per cent—was taken for the minimum net weight under mechanical-loading conditions. On this basis, 520 loads would have to be dumped for an output of 2,500 tons, increasing the round trips per car to 2.1 per shift.

More Mine Cars Avoided

But, by increasing main-line trip size three cars and assuming a slightly higher round-trip time of 32 minutes, a 36-minute leeway in main-line haulage time was indicated. This eliminated the sometimes necessary purchase of additonal pit cars to compensate for decreased car capacity with mechanical loading. However, the additional hoisting cost arising from the increase in the number of cars dumped was estimated at ½c. per ton.

A breakdown of mine output showed that 23.2 per cent (580 tons) came from development work (15-ft. places) carrying no yardage costs and that 76.8 per cent (1,920 tons) came from room faces (30 ft. wide), with the former yielding slightly more than 24 tons per place and the latter averaging exactly 48 tons per cut over a period of several months. Fourteen shortwall cutters with bars making 8-ft. cuts were in operation; four machines averaging 145 tons per shift per machine were used in development work, and ten, each averaging 190 tons per shift, were used in room work.

A change to high-speed mounted cutters operated by two-man crews was recommended for room production only. These machines—four in number—would average ten cuts, or 480 tons, per machine shift and increase output from slightly over 89 to an average of 156 tons per total cutter employee at the property.

TABLE I

	Minutes
Loading, 1.5 tons per minute	193
Car changing, 1.5 minutes per car	90
Moving loader, 5 minutes per move	60
Time safety factor, 6.4 minutes per place	77
Total shift time	420

TABLE II

Classification	Number	Total Cost Per Day
Foremen ($8.00 per day)	½*	$4.00
Cutting and drilling men ($6.86)	4	27.44
Shotfirers ($6.86)	½*	3.43
Loader operators ($6.86)	1	6.86
Loader helpers ($6.00)	1	6.00
Motormen ($6.16)	1	6.16
Brakemen ($6.00)	1	6.00
Track and timbermen ($6.00)	2	12.00
Facemen (laborers) ($5.76)	1	5.76
Total	12	$77.65

* One man to two loading machines.

TABLE III

	Minutes
Loading, 2.5 tons per minute	192
Car changing, 1 minute per car	100
Moving loader, 4 minutes per move	40
Time safety factor, 8.8 minutes per place	88
Total shift time	420

TABLE IV

Classification	Number	Total Cost Per Day
Foremen ($8.00 per day)	½*	$4.00
Cutters ($6.86)	2	13.72
Drillers ($6.16)	1†	6.16
Shotfirers ($6.86)	1	6.86
Loader operators ($6.86)	1	6.86
Loader helpers ($6.00)	1	6.00
Motormen ($6.16)	2	12.32
Brakemen ($6.00)	2	12.00
Relay (swing) motormen ($6.16)	½*	3.08
Trackmen ($6.00)	2	12.00
Timbermen ($6.00)	2	12.00
Facemen ($5.76)	2	11.52
Total	17	$106.52

* One man for two loaders. † Pro rata share of total number of men employed in drilling.

TABLE V

	Per Ton
Direct labor	$0.2326
Explosives	0.0300
Extra power	0.0225
Maintenance	0.0500
Depreciation and interest	0.0500
Total cost on main-line partings	$0.3851

TABLE VI

Face to Parting	Cost per Ton Hand Loading	Mechanical Loading
Cutting	$0.100	.....
Loading	0.720	.....
Gathering	0.050	.....
Supervision	0.005	.....
Dead work	0.040	.....
Timber and track	0.015	.....
Direct labor	.....	$0.2326
Explosives	.....	0.0300
Extra power	.....	0.0225
Maintenance and supplies	.....	0.0500
Depreciation and interest	.....	0.0500
Total	$0.930	$0.3851
Total Cost		
Coal to main-line partings	$0.930	$0.3851
Haulage and hoisting	0.025	0.0300
General mine maintenance	0.010	0.0200*
Preparation	0.050	0.0570
Engineering, management and overhead	0.155	0.1550*
Mine supplies	0.190	0.1900*
Power	0.080	0.0800*
Total	$1.440	$0.9171*

* Exclusive of charges growing directly out of mechanization, as listed above.

Moreover, the change would balance unit cutting-machine capacity with the indicated unit mechanical-loader capacity recommended under prevailing physical conditions.

To coordinate drilling with both cutting and loading cycles, four light-type power drills—one to accompany each shortwall machine—were selected for development work. While each such drill would have a capacity considerably in excess of the 48 8-ft. holes per shift they normally would have to put in (drilling, loading and tamping to be done by the cutting crews), one drill for each shortwall was considered the most convenient arrangement. Two high-speed mobile-type mounted drills, each with a two-man crew also doing the loading and tamping, were estimated to have a capacity of 160 8-ft. holes per shift in room work. Both development and room drilling were predicated on an average of one additional drillhole per 15- or 30-ft. face for the same quantity of explosive per place as under the hand-loading system.

Six Loaders Selected

For an average output of 2,500 tons per shift, with 23.2 per cent coming from development and 76.8 per cent from room workings, a battery of six heavy-duty mobile loading machines with capacities ranging from 3 to 6 tons of coal per minute was selected. Two machines were allocated to development work and four to room loading. Development-machine selection was based upon the analysis of time requirements for the various operations shown in Table I.

On this basis, each development machine would clean up twelve places, yielding 290 tons per shift, or 580 tons for the two machines. Averaging day-work labor accomplishments under hand-loading conditions, unit loading-machine crews to cut, drill, shoot, load and transport the coal, clean up, timber and lay track and supervise were set up. The make-up of these crews is set forth in Table II. With development-crew production averaging 290 tons per shift, or a little more than 24 tons per man, at a labor cost of $77.65 per shift (Table II), direct labor cost would be $0.2678 per ton of coal delivered on the main-line parting.

On the basis of distribution of loading-machine time in room work shown in Table III, each room machine would clean up ten places, yielding 480 tons per shift, or a total of 1,920 tons for the four machines assigned to this work. Crew make-

up for these machines is set out in Table IV. With room-crew production averaging 480 tons per shift, or nearly 28¼ tons per man, at a total outlay per shift of $106.52 (Table IV), direct labor cost would be $0.2219 per ton of coal delivered to the main-line parting. Combining crews and labor costs (Tables II and IV) gives a total of 92 men for six crews. With a production of 2,500 tons and an outlay of $581.38, average output per man-shift is about 27¼ tons, average earnings per man-shift are $6.32, and the average cost of coal delivered to the main-line parting is $0.2326 per ton.

As mechanical loading must be charged with all additional costs not encountered in hand loading, a strict comparison between the two systems must take into account a number of other items. The contract rate of 72c. for hand loading, for example, included explosives which were furnished by the miner. Under mechanical loading, this cost is transferred to the company and, with the additional detonators necessary, amounts to 3c. per ton.

Although reducing the number of cutting machines from fourteen to six decreases power consumption for that phase of operation, the addition of the drills, loading machines and the higher gathering-locomotive duty called for under the mechanization set-up means an actual net increase of 2¼c. per ton in power costs. Maintenance cost is increased 5c.: viz., labor for lubrication, adjusting and repairing, 2c.; lubricants, 1c., and repair parts, 2c. per ton. Depreciation and interest on the new equipment take another 5c. per ton. Thus the total cost of mechanically loaded coal delivered to the main-line parting becomes $0.3851 per ton. The breakdown of this estimated cost appears in Table V.

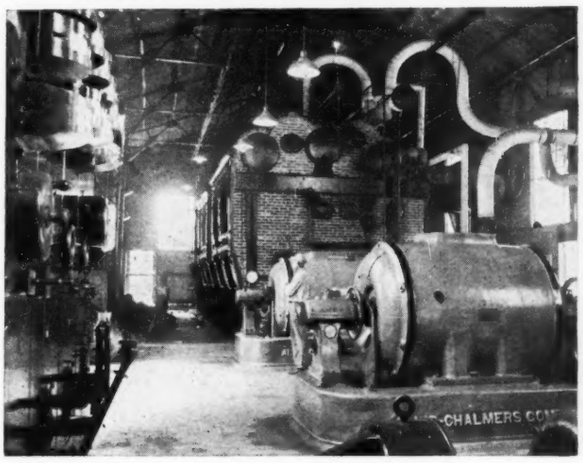
While certain costs from the main-line parting to the railroad car would not be affected by mechanization, certain others, such as main-line haulage and hoisting, general mine maintenance, picking, etc., would be increased. Taking all these items into account, a comparison between hand- and mechanical-loading costs (Table VI) shows a net saving of $0.5229 per ton, or slightly more than 36 per cent, in f.o.b. mine costs with mechanization. Revisions in cutting are responsible for $0.0561 of this saving and mechanization proper for $0.4668 per ton.

1,500-KW. POWER PLANT

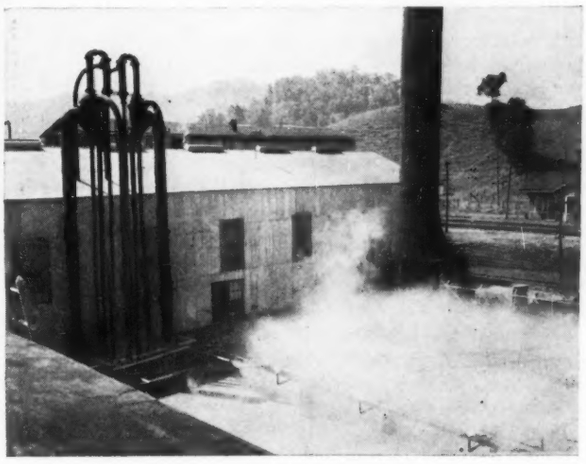
+ Built by North-East at Auxier Meets Long-Haul and Pumping Needs

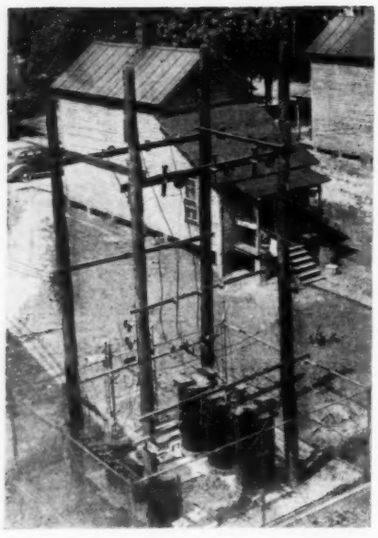
HAULS grow longer and influx of water increases—that's the way of mining—and costs go up, especially the power item. With purchased power in particular the mounting power bill gets the spotlight as the coal-company officials and executives strive to shave a corner here and there and keep the mine in the running. Such formerly was the situation at the Auxier (Ky.) mine of the North-East Coal Co., but for the next twenty years, estimated as the remaining life of the mine, it will be a different story. On May 1 the mine load was switched to an a.c. power plant built adjacent to the tipple and within

Three 361-hp. Stirling-type boilers and two 750-kw. turbo-generators



Barometric condensers, spray pond and self-supporting steel stack on 10-ft. concrete base





Transformer substation where generated voltage is stepped up for distribution to the mine substations and where the tipple and town lighting transformers are situated

1,000 ft. of the Big Sandy River.

This plant is on a site formerly occupied by a d.c. generating station which served the mine from its opening in 1909 until 1924, when, to combat the increased distance and excessive voltage drop of 275-volt transmission, a ten-year purchased-power contract was signed and substations were built near load centers. The mine has a 2½-mile outside haul, a slope 600 ft. long on a 17-per-cent grade, and an average inside haul of 1½ miles.

With the exception of two new feed pumps, the power plant with steel stack and spray-pond piping is used equipment which was purchased as a unit where it stood at the Flat Top (Ala.) mine of Sloss-Sheffield Steel & Iron Co. Once the source of power at Flat Top and for several years used as a reserve unit for an interconnected mine and furnace-plant power system tied in with lines of the Alabama Power Co. (*Coal Age*, October 1928, p. 594), the plant later had been taken out of reserve duty and made available for sale. Officials of the North-East Coal Co. supervised the dismantling, loading for shipment, and the construction at the new location; the McCabe Construction Co. was given a contract to do the brickwork of the furnaces, breeching lining, and stack lining.

Of the four 361-hp. Babcock & Wilcox Stirling-type boilers (160 lb. pressure now allowed), all but one were installed in the Auxier plant. Generating units consist of two Allis-Chalmers 750-kw. (181-amp.) 3,600-r.p.m. 2,400-volt three-phase 60-cycle Parsons turbo-generators rated for 125 lb. steam pressure and to operate condensing. The boiler furnaces, equipped as originally with Thomas shaker grates, are, for the present, hand-fired, using mostly run-of-mine coal but also some pickings of bone from the tipple and some track cleanings. The coal is the Millers Creek, which contains 36 to 38 per cent volatile and which, as mined at Auxier, carries less than 4.25 per cent ash in the nut-and-slack.

Condensers, one for each generating unit, are barometric type and the vacuum carried at usual loads and ordinary temperature is 28 in. mercury measurement. The spray pond is a concrete basin 80x85 ft. and 7 ft. deep. Make-up water is pumped direct from the Big Sandy River and is not treated. The 9x150-ft. self-supporting steel stack rests on a concrete foundation which extends 10 ft. above the ground. Steel breechings, which connect to the stack at ground level, are lined with firebrick from boilers to stack and the same material lines the stack to a point 40 ft. above the ground.

Boilers are equipped with Diamond flue blowers. The two new feed pumps are Gardner-Denver 7x4½x 10-in. duplex-piston type; vacuum pumps are 10x21x14-in. Worthington-Laidlaw feather-valve type. Serving each condenser unit is a pair of Midwest centrifugal pumps driven by a Westinghouse 50-hp. 2,300-volt induction motor. One pump of each pair delivers water to the sprays at the top of the condenser and the other pulls from the bottom and delivers to the sprays above the cooling pond. Exciting current for regular operation is furnished by a direct-connected motor generator and for starting and emergency by a second generator direct-connected to a high-speed vertical engine.

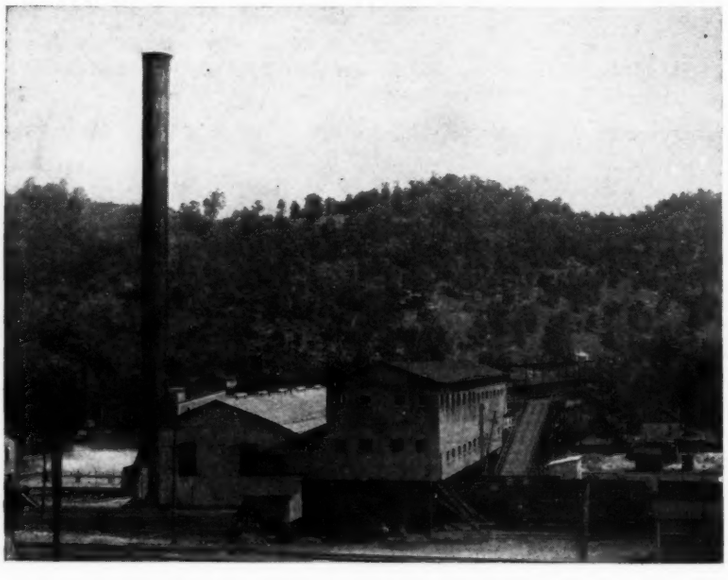
The frame of the steel building in which the plant is housed was purchased from an industrial concern which had erected the building but never used it. Dimensions are 40x 126 ft. and 25 ft. from ground to eaves. Sheathing is new corrugated galvanized steel, No. 22 gage on the roof and No. 24 gage on the sides.

At present the average daily load is 550 kw. and but one unit is used. The plant was started up on April 15, and on May 1 it permanently took over the entire load. At the time this article was written, however, the recording meters had not been adjusted to furnish accurate performance data. Production of the mine remains approximately the same as during the months included in the accompanying table, which sets forth data during a time when all power for the mine was being purchased. During May, 1937, when the mine operated 23 shifts, fuel consumption per day averaged 23 tons.

Exclusive of the small amount of additional tipple labor involved in switching and dumping cars directly to the power-house bins, power-plant labor operating payroll consists of six men. Occasional supervision over the plant is exercised by L. C. Gamble, chief electrician and master mechanic.

Distribution voltage to the mine substations was 6,600 volts with purchased power, and the metering point

Built adjacent to the tipple so that fuel can be dumped directly into the boiler-room bins



Tonnage and Power Data For Last Quarter of 1936

	Coal Shipped Tons	15-Minute Demand Kw.	Energy Used Kw.-hr.	Purchased-Power Cost
October	19,405	378	148,800	$2,270.50
November	17,219	540	149,400	2,479.00
December	20,616	540	171,600	2,701.00

was, in the direction of the mine, one mile distant from the tipple and company town. A No. 6 pole line brought power to the town site, where it was reduced to 110 and 220 volts by three 25-kva. transformers. Reversal and increase of power flow over this mile of 6,600-volt existing line required that the conductor size be increased to No. 2/0 (stranded copper is used).

Three General Electric 200-kva. transformers were installed at the town site to step the 2,300-volt generated power up to the 6,600 distribution voltage. The tipple and town power is thus stepped up to 6,600 and then reduced to 110–220, and the reason for this step-up and step-down is to save buying three new 25-kva. transformers or having the present transformers redesigned and rewound.

Dewatering of the mine is handled by four main pumping stations and the latest pump installed is driven by a 100-hp. motor. The total number of pumps, main and gathering, is 23 and the total pumping load approximates 300 kw. Two 10-ton and one 15-ton trolley locomotives handle the main haulage. Gathering is done with cable-reel units and the cutting by shortwall machines which work at night when the tipple is not in operation.

Four converters — two 150-kw. Ridgeway and two 200-kw. Westinghouse—and in that number of substations, supply d.c. for inside operations. Three of the substations are fitted with full-automatic controls. Other load on the power plant consists of a 100-hp. hoist which pulls trips of eight cars each up the 600-ft. slope.

In addition to Mr. Gamble, local officials who were concerned with the power-plant project are R. C. Thomas, superintendent of the Auxier and Thealka mines, and Herbert Wheeler, mining engineer. W. F. Pioch, of Red Dragon, W. Va., is general manager, and G. J. Beidenmiller, of Huntington, W. Va., is assistant manager. The Thealka mine—seven miles air line distant from Auxier—operates with a combination of purchased power and two d.c. generating plants.

PREPARATION EFFICIENCY

+ Goal at Hanna's Willow Grove Plant Designed for Three-Shift Operation

By IVAN A. GIVEN
Associate Editor, Coal Age

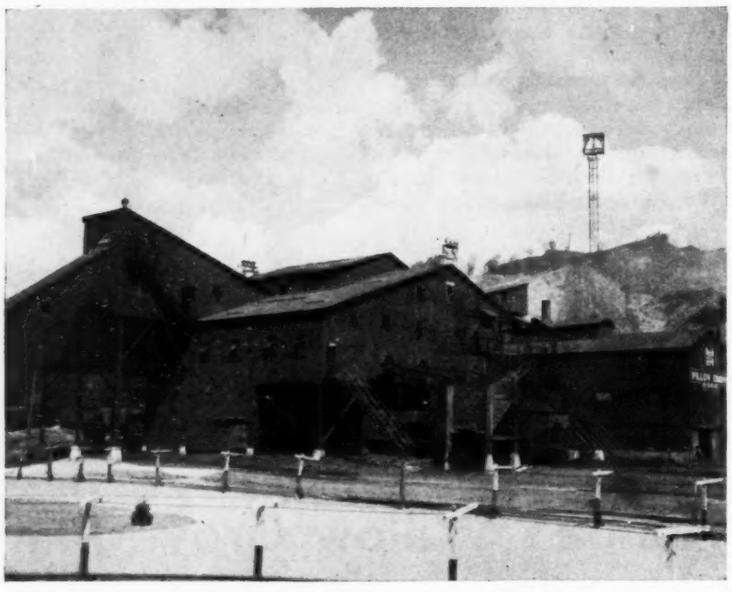
MARKET CONSIDERATIONS naturally were the primary reason for the new Willow Grove No. 10 preparation plant of the Hanna Coal Co. The Hanna objective for years has been to ship a high-grade fuel uniform in size and quality. This has meant under the Hanna set-up, installation of mechanical-cleaning equipment to supplement mechanical-loading equipment underground, thus accomplishing the second objective—an increase in loading-machine efficiency—by transferring the burden of impurity removal to the surface plant. Mechanical cleaning also makes it possible to eliminate impurities from the smaller sizes impracticable to hand-pick and at the same time insures a high degree of uniformity in the chemical characteristics of all sizes shipped.

The Willow Grove plant, 3 miles from St. Clairsville, Ohio, was completed early in 1936. The first coal was shipped May 12. During construction, the old Williow Grove tipple was kept in operation until a few days before the changeover. Loading booms and the dryer building now occupy practically the same site as the earlier preparation plant. All-steel construction features the new plant, designed, in consultation with coal-company engineers, and built by the Link-Belt Co. Four loading tracks are provided for shipping four primary sizes and combinations thereof, as well as certain special sizes derived from crushing, etc. Primary sizes are: 4-in. lump, 4x2-in. egg, 2x1½-in. nut, and stoker.

With modifications dictated by experience, Willow Grove design follows fairly closely that of the Fairpoint No. 9 plant, built in 1928. The 1928 plant, the first mechanical-cleaning operation to be installed at a Hanna property, also complemented mechanical loading, the mine and surface plant furnishing experience for mechanization of loading and cleaning at other company mines. Rated capacity of Willow Grove is 180 tons per hour with one washing unit. At present, however, the average plant input is close to 250 tons per hour without materially affecting washing performance. In designing Willow

Grove, provision was made for doubling the rated tonnage in the future by adding another washing unit, dryer and picking table, sufficient reserve capacity being built into all other equipment to take the 100-per-cent-greater input.

Usually all coal smaller than 4 in. is washed at Willow Grove, although fines smaller than 1¼ down to ½ in. can be bypassed around the washer if desired. As the working schedule is three shifts a day six days a week, all mechanical equipment has been designed with an eye to maximum continuity of operation. Conveyors



Willow Grove preparation plant. On top of the hill behind the plant is the intermediate tower of the aerial tramway for refuse disposal

are equipped with rivetless chain, and provisions have been made for quick repair of wear in conveyors, chutes, launders, etc. and for quick changes of screen jackets and cloths to reduce necessary shutdown time. A special flat-top picking conveyor constructed so that it will withstand hammering and sledging is employed. To increase recovery, a crusher is installed to break down and recirculate bands picked out of the lump coal, and arrangements are made for screening refuse from the secondary elevator on the washing unit prior to crushing and then rewashing the crushed oversize if it should become desirable.

Equipment also includes a filter to recover minus 28-mesh material from the wash water when desired, with the filter cake going to a dryer installed primarily for dewatering minus ½-in. washed coal. Lump or egg or both can be crushed, and a vibrating screen is employed to remove oversize from the crushed product when a strict upper limit is specified by the customer. Also, equipment handling the crushed product is arranged for loading this material separately if it is desired to ship it dry. A separate degradation screen removes breakage from the lump size, while the washed-coal classifying screen is arranged to permit combining and transporting the various sizes without transferring them to mixing or other auxiliary conveyors, thus eliminating degradation from this source. And to prevent segregation and insure proper mixing of the smaller sizes after cleaning and drying, a double-screw cut-flight paddle mixing conveyor has been installed.

Natural conditions result in a high preparation reject at Willow Grove. In an average seam thickness of 5 ft. 2½ in., bands and impurities aggregate 3½ in. Above the coal is 10 to 12 in. of drawslate which must be taken down after each cut unless it breaks down into the coal before that time. Another impurity is pyrites, locally known as "copper stone." Taking the bands and other impurities and the pyrites in the seam, together with drawslate unavoidably included in the coal in the loading process, the total reject averages close to 20 per cent.

Coal and rock come out of Willow Grove mine in the same trips. Mine cars are arranged for dumping to either side without uncoupling, the locomotive pulling the trip slowly across the top of the receiving hoppers while dumping is carried on. Two 150-ton steel hoppers receive the raw mine-run, with a third 50-ton hopper in the same line for mine rock. Gratings with 18-in. square openings are placed over the rock bin to prevent damage to the feeder and rock conveyor. All larger pieces are broken down by the dumping crew. A 48-in. manganese-steel apron feeder (50 tons per hour at a speed of 3 f.p.m.) moves the rock onto a 36-in.-wide chain-and-flight rock conveyor discharging into the main refuse conveyor in the tipple, which in turn carries rock and other refuse to an aerial-tramway loading station. Length of the rock conveyor, inclined about 28 deg., is 127 ft. between centers; capacity is 50 tons per hour at 75 f.p.m.

From the receiving hoppers, raw mine-run is fed onto the main conveyor by two 42½-in.-wide automatic reciprocating feeders, each with a capacity of 360 tons per hour. Thus, one feeder alone has a potential capacity sufficient to keep the plant going even after the tonnage is increased in the future. Both feeders are driven by variable-speed d.c. motors through single-reduction Link-Belt herringbone reducers, and controls are arranged so that motor speed, and in turn feeder speed, can be varied at will from the plant operator's platform over the washer. From the feeders, mine-run is elevated to the primary shakers by a 42-in.-wide flight conveyor with a capacity of 360 tons per hour at 100 f.p.m. Conveyor length is about 181 ft., of which approximately 53 ft. is horizontal and the remainder is inclined about 34½ deg. This high inclination was necessary because of the limited space available for installation of the dump hoppers and the loaded and empty mine-car tracks.

Welded Screens Employed

Mine-run screens at Willow Grove are constructed of welded ¼-in. steel plates, and are suspended on turnbuckle-type steel hangers. Length of the shakers is such that increases in capacity can be made by adding supplementary screen jackets. Another screen-design feature is the jacket hold-downs shown in an accompanying photograph. Sides of the jackets are turned up and in installing them the hold-down plates are placed over the turned-up sections and then are tightened by means of bolts passing through the screen sides to wing nuts. Thus, screen-changing time is cut to a minimum—a vital factor under a three-shift schedule.

Length of the triple-deck upper mine-run screen is 24 ft. The upper deck is fitted with 6 ft. of 1½-in. round

and 3 ft. of 2-in. round perforated plate to take out fines to serve as a cushion for 4x2-in. coal in later screening. The middle deck carries 12 ft. of stainless-steel plate with ½-in. round perforations, and the bottom deck, which acts as a carrier, is blank.

Length of the lower mine-run shaker is about 28 ft. The upper deck is fitted with 9 ft. of 4-in. round perforated plate for making 4-in. lump. The lower deck is blank, receiving 4x2-in. coal from the top deck and 2x½-in. or larger (up to 2x1¼-in.) coal from the second deck of the upper screen and discharging it through a gate and side chute into the washer-feed conveyor. Below the lower deck on the lower screen is a carrying chute receiving minus ½- up to minus 1¼-in. coal, depending upon the dressing of the second deck of the upper shaker, and discharging it into a side chute to the washer-feed conveyor. Both side chutes are divided to distribute the coal evenly on both sides of the conveyor.

Gates Bypass Slack

Gates in the side chutes, however, permit bypassing minus ½- to 1¼-in. coal to a 67-ft.-long 30x8½-in. flight conveyor. Operating at 100 f.p.m., this conveyor has a capacity of 137 tons per hour when transporting 1¼x0-in. coal. It feeds onto a 34½-ft.-long cross conveyor to either the paddle mixer or the main slack conveyor described below.

The lump picking table, receiving plus 4-in. raw coal from the top deck of the lower mine-run shaker, consists of a 48-in.-wide flat-apron conveyor 41½ ft. long between centers and operating at a speed of 40 f.p.m. Pans are stiffened on the back by 2x2x¼-in. angles and are mounted on two strands of 9-in.-pitch special closed-end cast-steel pintle (anti-bend-back) chains supported on 6-in.-diameter 4-in. face Timken-equipped rollers with Alemite fittings. This construction permits sledging or hammering when necessary in picking operations, and the flat top facilitates sliding off refuse. In addition to a skylight, picking-table illumination is afforded by 400-watt General Electric mercury-vapor lamps.

Eight pickings chutes, four on each side of the table, are provided. Four of the chutes at the head end of the table are reserved for pure refuse (bone and rock), while the four at the discharge end are reserved for bands or other material containing recoverable coal values. Pure refuse drops into a flight conveyor under the table en route to the main refuse conveyor. Bands and similar material drop into a 26x24-in. Link-Belt double-roll crusher designed to reduce the feed material to 80 to 90 per cent 2-in. cubes or smaller. Material through the crusher is carried back to the washer-feed conveyor by a 16x2-in. flight conveyor 56½ ft. long, of which approximately 31½ ft. is inclined 22 deg. Capacity is 35 tons per hour at 100 f.p.m.

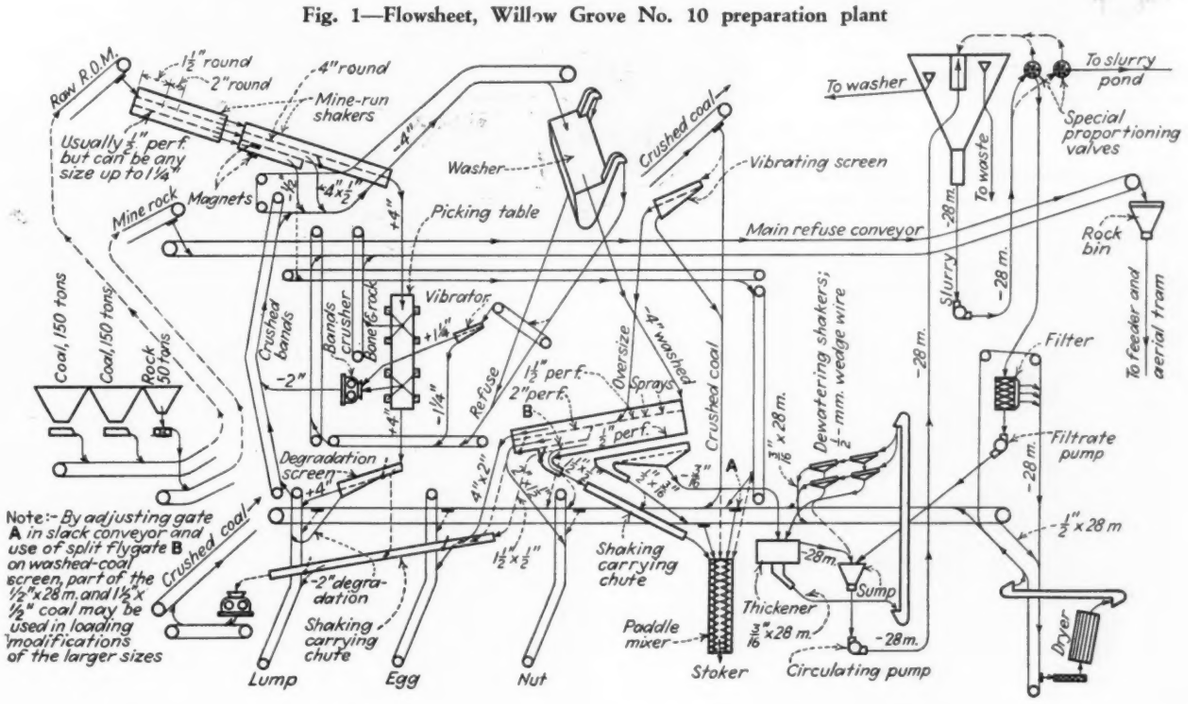
Hand-picked 4-in. lump slides off the table onto a shaking degradation screen fitted with 2-in. round-perforated plate. Undersize falls onto the lower run of the lump boom and is carried back to the crushed-bands conveyor. Coal over the screen flows onto a 48-in.-wide flight-type loading boom operating at 100 f.p.m. Capacity of this boom, when loading washed and cleaned mine-run made by remixing, is 320 tons per hour. A flygate in the degradation screen permits bypassing 4-in. lump to a carrying chute following the washed-coal classifying screens, on which lump can be routed to the coarse-coal crusher.

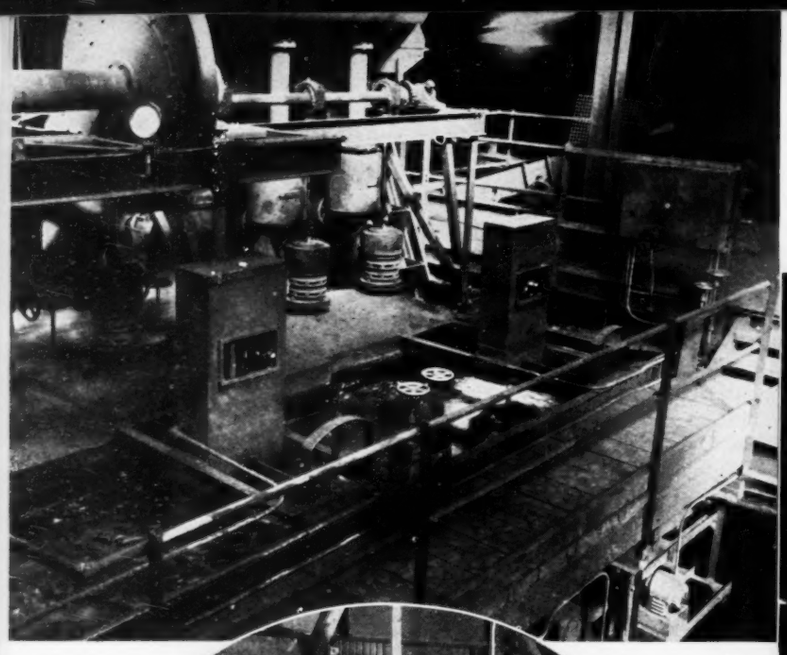
Washer Fed by Conveyor

Coal to be washed at Willow Grove is transported to the cleaner in a 36-in.-wide flight conveyor 53½ ft. long between centers and with the lower carrying run inclined about 35 deg. for about 38 ft. Capacity is 260 tons per hour at 100 f.p.m. As noted above, this conveyor also receives degradation and material from the bands crusher. By inserting divider plates in the future, the conveyor can be made to serve two washers, each from a separate compartment.

Washing is done in a 6-cell Link-Belt Simon-Carves unit with three refuse draws and two refuse elevators. Operation of the draws in the middle and at the discharge end of the washer are controlled by electric eyes. The draw at the feed end, however, is controlled manually, because the heavy slate and rock con-

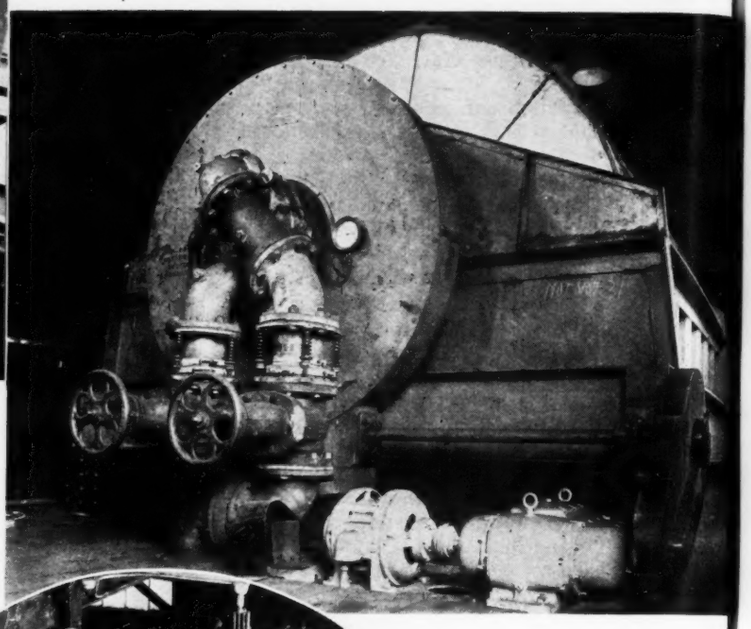
Fig. 1—Flowsheet, Willow Grove No. 10 preparation plant





All coal under 4 in. in size can be washed in this six-cell unit with three refuse draws, two with electric-eye control

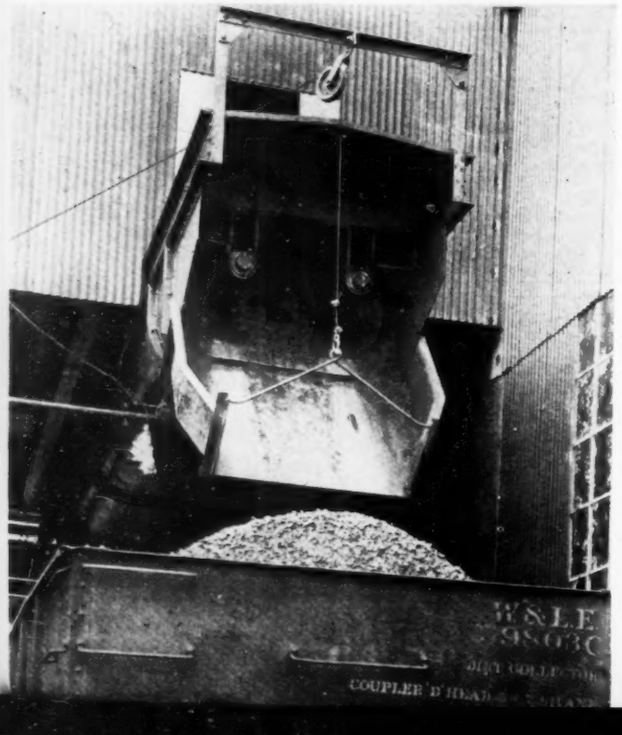
Continuous filter for recovering 28-mesh material in the wash water

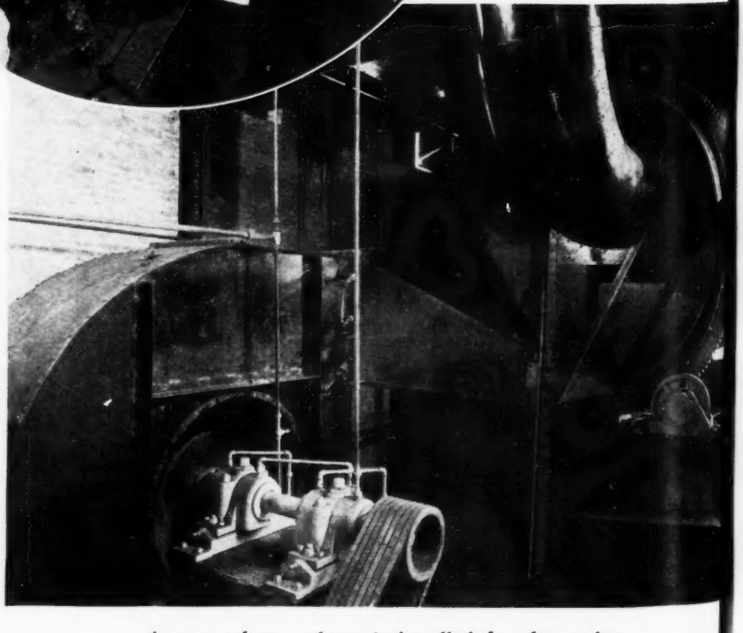


Upper mine-run shaker, showing hold-down plates and wing nuts for quick changing of screen plates

Flat-apron picking table for 4-in. lump. Illumination is supplied by mercury-vapor bulbs rated at 400 watts each.

Recombination of the finer sizes after cleaning and drying, without segregation, is assured in this paddle mixer





A rotary louver dryer is installed for dewatering coal under ½ in. in size

centration at this point lends itself better to manual control. Refuse draws for both heavy rock and slate, and also bone (middle draw), were installed with the idea of removing all of this material to one refuse elevator before it reached the last washing compartments, so that the final compartments and the secondary refuse elevator would be available for intermediate-gravity material, including laminated material carrying coal values. Thus, in case much laminated material should appear in the seam, which has been the case from time to time at other Hanna operations, it would be possible to revise the washing set-up to recover, crush and rewash the coarser material from the secondary elevator.

Equipment is now in place for coarse secondary-refuse recovery and reduction, and consists of a 16x2-in. flight conveyor from the secondary elevator to a 4x6-ft. Mogul Niagara vibrator. On this vibrator the secondary refuse would be separated into plus and minus 1¼-in. fractions, the undersize going to the main washery-refuse conveyor (16x2 in., 65-ft. centers, 45 tons per hour at 100 f.p.m. This conveyor feeds into another 16x2-in. cross unit delivering to the main refuse conveyor). Oversize from the vibrator would be dropped into the bands crusher for reduction prior to recirculation to the washer.

Screens Follow Washer

Washed coal is sized on two classifying screens, one mounted above the other. Both screens, hung on flexible wooden hangers and designed to permit providing additional jackets to increase capacity, are inclined 1 in. in 12 in. and operate at 150 strokes per minute. Width of the upper screen is 6 ft.; length, about 32 ft. The top deck is dressed with 15 ft. of 1½-in. and 7½ ft. of 2-in. round-hole plate. A short intermediate deck under the 2-in. section permits gathering 2x1½-in. nut for routing either to the shaking carrying and distributing chute following the classifying screens or to the nut boom. Fifteen feet of ½-in. round-hole plate on the bottom deck permits separating minus ½-in. material out of the minus 1½-in. coal through the top deck for subsequent treatment as indicated in the flowsheet, Fig. 1. The 1½x½-in. coal over the bottom deck may be run to the shaking distributing chute, to the slack conveyor indicated in the flowsheet, or to an auxiliary shaking carrying chute to the paddle mixer.

Width of the lower washed-coal classifying screen is 6 ft. It is dressed with 15 ft. of No. 13 U.S.G. Ascoloy plate with ⅜-in. round perforations. Water and minus ⅜-in. coal through this screen run to a thickener, while the ½x⅜-in. coal goes onto the slack conveyor. This slack conveyor, a 30x10-in. flight unit with a capacity of 230 tons per hour at 100 f.p.m., performs a number of functions, of which the principal one is handling coal under ½ in. to the paddle mixer, or to the dryer and back to the paddle mixer, as indicated in the flowsheet. The conveyor also may be used for taking coal under ½ in. back to the booms for mixing either wet or after drying, and also receives for mixing raw screenings bypassed around the washer.

Coal 1½x½ in. in size also may be run to the slack conveyor for mixing, but usually mixing of this size with the other larger sizes made on the classifying screens is accomplished on the shaking distributing chute, as indicated in the flowsheet. The chute also transports egg to a 36-in.-wide flight-type loading boom with a capacity of 230 tons of 4x0-in. coal at 100 f.p.m. The nut boom is identical with the egg boom, except that the capacity is 290 tons, the maximum to be expected when handling crushed coal in addition to the regular size run.

All sizes above 1½ in. can be transported on the carrying chute to a Link-Belt 36x60 adjustable double-roll crusher. By varying the adjustment, the top size of the crushed product also can be varied from 4 in. down to 1½ in. A short flight conveyor delivers the crushed coal to a 24x13-in. flight unit with a capacity of 210 tons per hour at 100 f.p.m. The latter conveyor elevates the coal 26 ft. to a Link-Belt PD-1510 single-deck vibrating screen. This screen is used only when strict oversize limits are specified for the crushed coal, in which case the oversize is returned to the washed-coal classifying shakers. Otherwise, the crushed coal is bypassed around the screen, usually to the nut boom or the paddle mixer.

Thickener Takes 3/16-In. Coal

Minus ⅜-in. coal and water through the lower classifying screen are run to a Dorr Type A hydroseparator, or thickener (19-ft.-diameter tank 8 ft. 10 in. high). The hydroseparator separates minus 28-mesh fines from the rest of the coal by overflowing them with the water while the ⅜-in. x 28-mesh material is withdrawn through the bottom. Rake-arm speed is governed by a Link-Belt "P.I.V." gear. Overflow water carrying minus 28-mesh material is pumped up to a 50-ft.-diameter settling cone by a 2,500-g.p.m. centrifugal pump. Thickener underflow (⅜-in. x 28-mesh) is delivered to two pairs of 4x10-ft. dewatering shakers by a Luhrig elevator. Present capacity of the elevator, inclined about 70 deg., is 38 tons of coal and 38 tons of water per hour at 90 f.p.m. Capacity can be doubled in the future by doubling the number of buckets.

Filter Handles Slurry

The dewatering shakers, with welded frames, are dressed with stainless-steel wedge-wire sieves having ½-mm. openings. Water through the sieves is returned to the hydroseparator, while the coal goes either to the top or bottom strand of the main slack conveyor, depending upon whether it is to be loaded wet or dry.

Slurry from the settling cone (minus 28-mesh coal and water) may either be pumped to a settling pond or to an 8½-ft.-diameter six-disk American continuous filter with 560 sq.ft. of filter area. Two special valves, consisting of disks with various-sized openings, permit the slurry to be split in any desired proportions between the settling cone and the filter, or the cone and the slurry pond. Although a clarified-water overflow is installed on the settling cone, the difficulty of disposing of this overflow, inasmuch as dumping it into the creek is forbidden, has moved preparation officials to adopt the closed-circuit system, except for such water as is removed with the slurry. As yet, working with a closed circuit has resulted in no washing difficulties. Such make-up water as is necessary is added through clear-water sprays on the washed-coal classifying screens. This make-up water is obtained from the creek when the flow is sufficient. Otherwise, it is pumped from a deep well at Neffs, Ohio, about two miles away, through a 6-in. Crane enamel-lined black-pipe line with Hill-Hubble coating.

Rated capacity of the filter is 16.3 tons per hour of sludge containing 35 per cent of solids by weight yielding a filter cake containing not over 22½ per cent of surface moisture under the above rate and conditions when the insoluble solids in the feed do not contain over 25 per cent of sizes under 200-mesh. The filter cake obtained is combined with ½x⅜-in. and ⅜-in. x 28-mesh coal from the classifying and dewatering screens for drying.

Drying equipment at Willow Grove consists of a Link-Belt rotary louvre dryer 10 ft. 3 in. in diameter and 30 ft. long. Coal is brought to the dryer on the lower run of an 18x8-in. flight conveyor with a capacity of 40 tons

per hour at 126 f.p.m. A 10-ft.-long screw conveyor transfers the coal to the dryer, which is designed to evaporate 9,000 lb. of water per hour from 40 tons of washed coal. Hot air at 900 to 930 deg. F. is supplied by a pulverized-coal furnace transferred from Fairpoint No. 9. Air from the furnace passes into a tempering chamber where automatic controls admit cold air as necessary to give the required temperature. Additional controls govern the volume of hot gases entering the dryer and also opening of the stack damper to dissipate accumulations of heat when the dryer is stopped.

Hot air is supplied to the dryer louvers by a special stainless-steel blower with a capacity of 46,000 c.f.m., 930-deg. air. Louvers run the full length of the dryer, and heated air is admitted only to those directly under the coal for maximum drying effect. Moisture-laden air is removed by a 27,000-c.f.m. exhaust fan. Dried coal is discharged into an elevator which lifts it to the top strand of the service conveyor, which in turn discharges the dried material on the bottom strand of the main slack conveyor.

Thorough Mixing Assured

A feature of the Willow Grove plant is the means for mixing the smaller sizes after cleaning and drying to prevent segregation. As indicated in the flowsheet, the mixing equipment is required to handle, at times when the dryer is operating, both wet and dry coal and at times also receives crushed lump and egg from the coarse-coal crusher. Thorough mixing is necessary to assure uniformity in the distribution of sizes and moisture in the shipped product. This is done in a horizontal paddle mixer consisting of twin 27-in.-diameter double-cut-flight screw conveyors with paddles approximately 22 ft. long operating in a U-shaped steel trough. Conveyor speed is 50 r.p.m. The various sizes of coal are received at two points approximately 6 ft. apart near the feed end of the unit and after mixing are discharged into a chute at the opposite end of the mixer. Mixer capacity is 315 tons per hour.

A slide gate in the bottom of the mixer trough about 6 ft. back from the discharge end permits diverting the coal while changing railroad cars and thus makes it unnecessary to shut the unit down. Gates also are provided about half way back on the inclined sections of the nut and egg booms for the same purpose, while the lump boom is equipped with a Jeffrey pantograph-type diversion chute, which is brought into position as the boom is raised. The plant design also provides for the later installation of a conveyor across the end of the loading-boom bay for custom-coal service, the conveyor, to serve a number of custom-coal hoppers, receiving coal from the booms in raised position.

Excluding refuse-disposal equipment, make-up water pumps, boom hoists and certain other small miscellaneous motors, the Willow Grove preparation plant is operated by 53 motors aggregating 1,064 hp. D.c. motors are employed on the mine-run feeders to make it possible to secure any desired variation in speed between 600 and 1,200 r.p.m. without loss of horsepower, and 2,200-volt units are used on the filter vacuum pump and dryer hot-air blower. General Electric 440-volt motors, with a few exceptions, are installed throughout. Types and other characteristics are given in Table I, along with drive data. In a few instances, MT-motor characteristics have been modified by "shorting" the rings. Westinghouse control equipment is standard, and plant operation is centered in a pushbutton-control panel with indicating lamps above the washer. "De-ion" breakers are used in combination with all starters. The magnetic combination-type starter leads in number. Non-reversing magnetic timestarters providing dynamic braking control the d.c. feeder motors. A secondary resistor is employed in most of the starters for conveyors and crushers. Reduced-voltage auto-transformer starters operate the circulating water pump and blowers, and a speed-regulating rheostat is employed in connection with the dryer drive.

Drives, with a few exceptions, are

Table I—Details of Motor and Drives, Willow Grove Preparation Plant (a)

	Motors				
	No.	Hp.	R.P.M.	Type (b)	Drive (c)
Air compressor, dumping units	1	25	900	H (d)	Direct
Mine-rock feeder (3 f.p.m.)	1	5	900	KT	Reducer
Mine-run feeders (2)	2	10	1,200/600	CD (e)	Reducers
Mine-rock conveyor (75 f.p.m.)	1	50	900	MT	Reducer
Mine-run conveyor (100 f.p.m.)	1	100	720	MT	Reducer
Mine-run screens (110 s.p.m.)	1	25	900	FTR	V-belt
Picking table (40 f.p.m.)	1	3	1,200	KT	Reducer
Table-refuse conveyor	1	5	1,200	KG	Reducer
Bands crusher	1	10	600	FT	V-belt
Crushed-bands conveyor (100 f.p.m.)	1	5	1,200	MT	Reducer
Lump degradation screen	1	5	1,200	KG	V-belt
Lump boom (100 f.p.m.)	1	15	1,200	MT	Reducer
Slack bypass conveyor (100 f.p.m.)	1	15	1,200	FTR	Reducer
Bypass cross conveyor (100 f.p.m.)	1	10	1,200	KT	Reducer
Washer-feed conveyor (100 f.p.m.)	1	25	900	KG	Reducer
Washer compressor	1	30	3,445	KF	Direct
Washer elevators	1	15	1,200	MT	Reducer
Washer-reject draws	3	1½	1,720	K	Reducers
Washer-refuse conveyors (100 f.p.m.)	2	5	1,200	KT	Reducers
Secondary refuse conv. to screen (100 f.p.m.)	1	5	1,200	KT	Reducer
Secondary refuse screen	1	5	1,200	MT	V-belt
Main refuse conveyor (75 f.p.m.)	1	50	700	FTR	Reducer
Upper washed-coal screen (150 s.p.m.)	1	30	860	KG	V-belt
Lower washed-coal screen (150 s.p.m.)	1	5	1,200	KG	V-belt
Auxiliary shaking carrying chute	1	10	1,200	KG	V-belt
Egg and nut booms (100 f.p.m.)	2	10	1,200	KG	Reducers
Main slack conveyor (mixing) (100 f.p.m.)	1	15	900	FTR	Reducer
Paddle mixer	1	25	1,200	KG	Bevel gear
Washed-coal crusher	1	100	720	MT	V-belt
Crushed-coal conveyor No. 1 (100 f.p.m.)	1	5	1,200	KT	Reducer
Crushed-coal conveyor No. 2 (100 f.p.m.)	1	25	900	MT	Reducer
Crushed-coal screen	1	5	1,200	KT	V-belt
Hydroseparator	1	3	1,200	K	V-belt and reducer (f)
Luhrig elevator	1	15	900	FTR	Reducer
Dewatering screens	1	7½	1,200	FTR	V-belt
Circulating water pump	1	75	900	KT	Direct
Slurry Pump	1	7½	900	FT	Direct
Filter	1	3	1,200	KG	V-belt and reducer (f)
Vacuum pump	1	60	1,160	K (g)	V-belt
Filtrate pump	1	5	1,760	K	Direct
Blower	1	3	1,160	K	V-belt
Dryer service conveyor (126 f.p.m.)	1	25	870	KG	Reducer
Dryer-feed screw conveyor	1	5	1,200	KG	Worm red.
Dryer	1	20	1,200	MT	Reducer
Hot-air blower	1	100	960	KT (g)	V-belt
Exhaust fan	1	30	1,200	KF	V-belt
Dried-coal elevator	1	7½	1,160	KG	Reducer
Pulverizer drive	1	20	1,800	FTR	Direct

(a) Exclusive of boom hoists (Shaw), refuse-disposal equipment, make-up water pumps, heating units etc. (b) All motors General Electric, 440 volts, except as indicated; on certain MT motors, rings are shorted to modify characteristics. (c) Link-Belt herringbone reducers and Dayton "Cog-Belt" drives used with some exceptions; connections from reducers to driven shafts predominantly Link-Belt "Silver-Link" roller chains. (d) Fairbanks-Morse. (e) Shunt-wound d.c. motors to permit any variation in speed between 600 and 1,200 r.p.m. without loss of horsepower. (f) Includes Link-Belt "P.I.V." variable-speed gear. (g) 2,200 volts.

of either of two types: Link-Belt herringbone-gear reducers with Link-Belt "Silver-Link" roller chains between reducers and driven shafts or Dayton "Cog-Belts." The roller chains, it is felt, make speed changes quicker by merely replacing sprockets when necessary.

To facilitate repairs without undue loss of time, all conveyors, feeders, chutes and launders are furnished with renewable liners for the bottoms and also for the sides where necessary. Except for certain conveyors handling heavy rock and similar material, liners are made of 0.40-carbon steel. The same applies to track slides and wearing bars for conveyor chains. Washer-refuse conveyors have bottom liners of 1-in.-thick hard white iron, and the same material is used on the bottoms and sides of the mine-rock and main refuse conveyors. Also, 4-in.-thick oak planking is placed under the points where material is received on both the latter conveyors. As far as possible, bottom plates in conveyors are arranged for quick removal and replacement, this involving, among other things, accurate drilling of bolt-holes so that sections are interchangeable and conveyor sizes are standardized as far as practicable to reduce the repair-part inventory.

Four foremen and 66 men are required to operate the Willow Grove plant per day of three shifts, exclusive of men involved in refuse-disposal. At least one representative of the company's analytical department is on hand at all times when the plant is working to oversee preparation, and at least fifteen control samples, primarily egg and stoker coal and refuse, are taken every day. Coal samples are run for ash in accordance with Hanna's general practice, which is based on the philosophy that ash is the figure the purchaser considers and therefore is the one by which the operating department should work.

Tramway Handles Refuse

Refuse-disposal at Willow Grove is handled by a double reversible aerial tramway which went into operation early in September. This tramway, furnished by the Americal Steel & Wire Co. and operated by one man, replaces a skip hoist and larry formerly used to deposit refuse in terraces along the hillside back of the plant. With the tramway, refuse is carried to a comparatively flat storage space on top of the hill.

Length of the tramway is about 2,325 ft. and the elevation of the tail towers above the loading terminal is 482 ft. Maximum tramway capacity, with two 108-cu.ft. buckets each holding 9,180 lb. of refuse, is 120 tons per hour with an average traction-rope speed of 850 f.p.m. Bucket carriers are equipped with automatic tripping mechanisms. A special $1\frac{7}{8}$-in.-diameter locked-coil track cable is employed, along with a $\frac{7}{8}$-in. 6x19 Lang-lay traction rope.

In addition to two 200-ft.-high tail towers, the tramway includes an intermediate tower, or curved saddle and angle mast, also 200 ft. high and located about 770 ft. away from the loading terminal. Both tail towers and the intermediate tower are guyed in position. At present, the traction rope is driven through a reducer by a 75-hp. motor; when capacity is increased later, a 125-hp. motor will be employed with the same reducer.

Two batch-type loading hoppers are employed. Loading-hopper gates are operated by $\frac{1}{2}$-hp. motors. Operation of the feeder to bring refuse from the storage hopper to the loading hoppers is controlled by weight of the material in the latter. Loading-hopper gates are equipped with limit switches to make sure that they are withdrawn before the tramway buckets are sent out. Electric-eye controls are installed to stop the buckets just before they come into the loading terminal. After a bucket is stopped, a jog control is used to bring it in for loading.

ELK HORN DRAMATIZES

+ Story of Coal for Home Heating

With Ground-Floor Stoker Exhibit

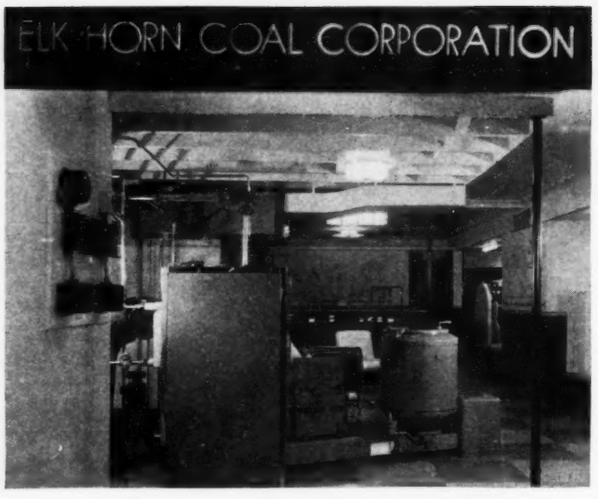
SURVEYING the earthly coal scene a few years ago, the mythical visitor from Mars might easily have been forgiven for reaching the unflattering conclusion that the coal industry deliberately avoided exposing itself to the public gaze. Producers and wholesalers made little or no attempt to display their wares to the domestic consumer; that, in their philosophy, was the exclusive function of the retail distributor. The latter, usually with headquarters off the beaten track of the casual shopper, seemed equally reluctant to dramatize his service; true, he might indulge in occasional direct-mail, local newspaper or billboard advertising, but there, generally, his promotional efforts stopped.

Competition however, is changing this picture. Operators with a big stake in the domestic market threatened by oil and gas no longer are content to leave the job of consumer merchandising entirely up to the retailer. Dealer-help campaigns, prepared and in many cases mailed by the producers, have grown both in number and elaborateness. Radio has been tried. Combustion engineers employed by mining companies have been turned loose to work with the retailer and his customers. Direct advertising by producers to the consumer also is increasing. Still more is in prospect.

The advent of the small stoker has opened new opportunities for drama-

Be Your Umbrella!
YOU ARE BUYING Protection FROM THE ELEMENTS USUALLY FOUND IN INFERIOR STOKER COALS When YOU BUY WAYLAND WASP
WAYLAND WASP

Advising the newlyweds on home comfort



A show-window glimpse of stoker exhibit

tizing coal's service to the householder. Producers with a keen sense of merchandising have realized that here is something which will catch the public eye much more effectively than the old-time display of different sizes of coal in dusty showcases. So here and there operating companies have been taking ground-floor space in prominent urban locations to attract the attention of Mr. and Mrs. Paterfamilias on their wanderings about town. One of the most striking of these ventures is that of the Elk Horn Coal Corporation in Chicago.

This showroom, opened Sept. 1, 1936, is on the southwest corner of Michigan Avenue and Van Buren Street, with a subway entrance to the Illinois Central R.R. in front of the door. Thousands of commuters use this subway—and the average commuter is not an apartment-house dweller but an individual home owner with an individual heating problem to handle. Michigan Avenue also is a favorite parade ground with a steady stream of window shoppers. Because the Elk Horn display is open five days a week from 9:00 a.m. to 9:30 p.m., post-prandial strollers, as well as ordinary business-hour visitors, also have a chance to drop in. On Saturdays the exhibition closes at 6:00 p.m.

Attractive window displays, which do not obscure the view of the interior of the showroom, make the first eye appeal to the passing throng. While the schedule calls for a change in these displays every three months, special displays having only a short-time appeal actually make the changes more frequent. For example, a few days before Thanksgiving, one of the windows blossomed out with a "coal meal" in which coal was

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• The opening of our ground-floor office in Chicago was essentially an experiment. Behind the entire idea was a desire on our part to cooperate with our retail customers in Chicago and partly to promote the sale of solid fuel. We feel that we have been successful in both of our aims. We have done something worth while for our retail customers by familiarizing the general public with Wayland Wasp coal and also in selling stokers and assuring ourselves of solid-fuel customers for years to come.—*Carter H. Schupp, general manager of sales.*

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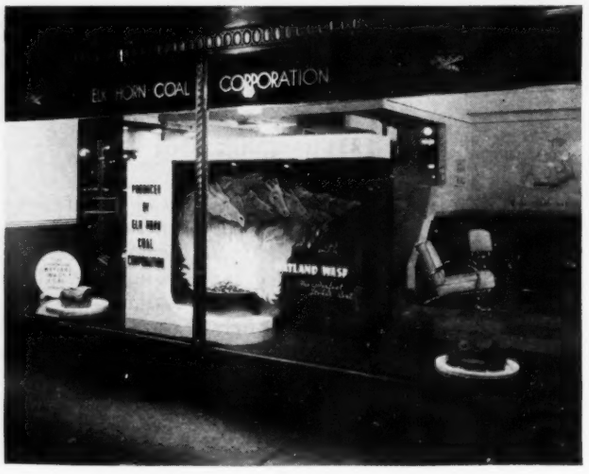
Sherlock Holmes does a little sleuthing



Dramatizing coal's "flaming horsepower"

used to simulate various seasonal comestibles. The coronation in London last spring was signalized with a doll show carrying the message that Wayland Wasp was the king of stoker coals. June paid its tribute to the brides and urged them to rely on Elk Horn coal to escape the squalls of stormy weather.

Inside, as shown in the illustrations, is a comfortably arranged layout where modernistic furniture contrasts with more antiquely flavored mural drawings of the early history of coal. The heart of the inside display is a domestic stoker in operation. These, too, are changed every two months. During the first year the showroom was open, prospects had an opportunity of seeing models of the Iron Fireman, Auburn, Combustioneer, Anchor, Stokol and Whiting under actual firing conditions. Representatives of the particular manufacturer whose stoker is on display are at hand to answer questions and explain the operation of the equipment. A large number of leads and many direct sales of stokers have resulted from the interest thus generated.

Both stoker manufacturers and retail coal merchants are encouraged to use the showroom to demonstrate automatic coal heat to prospects and customers. Many have taken advantage of this opportunity. The householder, of course, gets not only a close-up of the stoker, with which, in most cases, he has been unfamiliar, but also is impressed with the suitability of Elk Horn Wayland Wasp coal for stoker use. This impression can be created without any direct sales talk because the entire setting—room arrangement, decorations, floor and wall exhibits—contributes to that end.

Elk Horn further promotes the common interests of itself and its retail distributors in the area by furnishing visitors with an up-to-date list of Chicago retailers who handle Wayland Wasp coal. As this list includes approximately 80 dealers in all parts of the city, the consumer is offered a wide choice of sources of supply. And the list itself naturally is a subtle invitation to progressive retail coal merchants to climb aboard the Elk Horn bandwagon.

An appearance of inviting spaciousness characterizes the Elk Horn showroom

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NOTES

From Across the Sea

IN COAL SAMPLING, the major problem is how to persuade people that it really is a problem and not a simple matter, declares C. W. H. Holmes, in the *Colliery Guardian*. Sampling usually is intrusted to a dayhand, who takes several samples of different kinds and sizes of coal, often without being told how he is to take them. Yet even when coal is sampled with a care and at a cost such as the best of good judgment would indicate, no close approach will be made to accuracy.

If, for instance, an average analysis of about 500 tons of unwashed slack on any given day shows 9.37 per cent of ash, all that can be asserted with safety is that the ash in the slack runs between 9 and 10 per cent, and if the sample was taken from the tops of the cars that it runs between 8½ and 10½ per cent. Why, then, trouble about second places of decimals? Greater accuracy, of course, could be attained, but, with material as cheap as coal, the cost of sampling must be kept within bounds.

Mr. Holmes does not add that the sample when crushed is a product salable at a lower price than the uncrushed material, whereas with a metallic ore the breaking of the sample adds to its value, as all ore has to be crushed before or in the course of beneficiation.

If, of ten pieces of "coal" taken in sampling, nine had 5 per cent ash and one was really dirt and not coal at all and had 75 per cent of ash, the ash content of the sample would be 45 plus 75, or 120, divided by 10, or 12 per cent, but, as the dirt particle is about twice the weight of the coal particle of the same size, the ash content of the sample would be 45 plus about 150, or about 195, divided by almost 11, or, roughly, 18 per cent. If the ten pieces of "coal" had all chanced to be of 5 per cent ash, then the sample would be found to have 5 per cent ash, but with a single piece of dirt of 75 per cent ash it will be found to analyze 18 per cent ash.

It is clear, therefore, that the sample is likely to show a percentage of ash varying from 5 to 18. Obviously, it is necessary to take more than ten pieces to get a result having any real value. Even with 100 pieces, if one piece were of 75 per cent ash, the ash content would rise from 5 per cent to 6.4 per cent.

Washing, by removing all "coal" but that not exceeding 30 per cent ash, would still leave the results of sampling variant and uncertain. Though the variations would be less, they would be regarded as more important, for the buying public demands more of washed than of raw coal. No wonder the size-weight ratio has been introduced, for the weight of the sample will increase with the size of the pieces, and the number of pieces taken is the criterion of accuracy and not the gross weight.

But the variant size of the pieces enters into the problem, for some sizes of coal have more ash than other sizes from the same mine. Where the coal from a mine or a washery is sampled at a given time each day, the sample, however large, is unrepresentative, asserts Mr. Holmes, for the character of coal varies through the day. The morning coal may be full of kirvings, because cutting has been done at night, and the cuttings are loaded out in the morning.

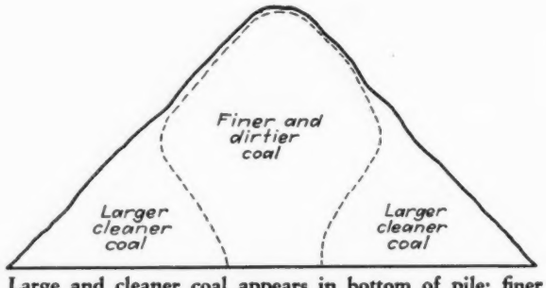
In at least one American mine, it may be added, the morning's coal is washed for railroad use and the afternoon's coal for metallurgical coal, because the morning coal cannot be made clean enough for the manufacture of high-grade coke, being in large part coal derived from kerf cuttings. On the other hand, some mines reserve the kirvings for metallurgical coal because it happens in that instance that they constitute the cleanest part of the seam.

Segregation also enters into the problem, according to Mr. Holmes. When dropped on a pile, the larger pieces, under the influence of gravity, travel faster and further than the smaller, and inspection reveals that the larger particles are patently grouped mostly around the foot of the pile, and the small particles find their way to the interior. The large coal at the base of the pile is relatively clean, for the heavy large pieces sink through the curtain of moving coal and come to rest among particles finer than themselves. Thus size segregation and density segregation both occur.

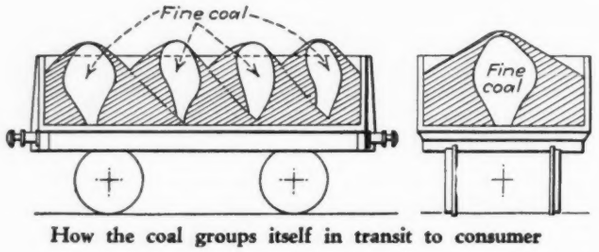
Consequently, taking a sample from a conveyor fed from another running at an angle to it will not be representative, for the coarse particles will be thrown further than the fines. Neither the coal in the center line nor on the right nor the left of the belt will give a true sample. Nor will the sample be representative as taken from a bunker used for regulating the delivery of coal, for in the bunker segregation occurs.

If samples are taken from 100 separate cars of coal and the average ash content proves to be 10 per cent, the differences between that figure—10 per cent—and the actual percentages of ash for each of the several cars may add perhaps to 120, or an average of 1.20 for each of the 100 tests. This is known as the average error, and it can be altered substantially only by changing the sampling method, the total weight of material sampled or the number of "increments," or grab samples, that are taken. Taking this average error and multiplying by 0.85 we get the probable error, which in this case would be almost exactly 1 per cent, and from this it is known that 50 per cent of the analyses will be between 9 per cent and 11 per cent ash and the other 50 per cent outside these limits, for the distribution of error in practice follows closely that indicated by this law of probability.

The British Standards Institute, says Mr. Holmes, recommends that 99 per cent of the results within plus or minus 1 per cent of the average ash content should be the standard of accuracy and advises an increase in the number of increments when high-ash, and conse-



Large and cleaner coal appears in bottom of pile; finer at top and interior



How the coal groups itself in transit to consumer

quently heterogeneous, coal is being sampled. If the weight of the sample is doubled by doubling the number of increments, the error is reduced only to about three-quarters of its original value.

Mechanical crushing and separation of parts of samples may give good results where all the sample is of equal hardness, but if the material varies, being partly of soft coal and partly of hard shale or pyrites, the retained material may have a different analysis from the discard, and this should be checked periodically to ascertain whether the mechanical sampling gives reliable results.

Producers of coal, if they sample their product as carefully as the consumer, are likely to get more correct results, for the coal in transport segregates so that the consumer can get equally good results only by taking more increments and using more caution. The fine coal comes first on opening the door of a hopper car and nutty coal appears first with end or side tippers.

R. Dawson Hall

On the ENGINEER'S BOOK SHELF

Orders for all books and pamphlets reviewed in this department should be addressed to the individual publishers, as shown, whose name and address in each case is in the review notice.

The Effect of Fibre Cores on Internal Corrosion in Colliery Winding Ropes, by J. E. O. Mayne. Safety in Mines Research Board (British) Paper No. 97. British Library of Information, New York. 38 pp., 6x9¾ in.; paper. Price, 35c.

"Batching" is wetting of fiber with fluids to lubricate it and render it more flexible, so that it can be spun into yarn and strands. Cores for winding ropes, declares Dr. Mayne in this study, normally consist of three strands. Oil-water emulsions are generally used in batching, but, because internal corrosion possibly may result, fibers for hoisting ropes are now treated solely with thin mineral oil. Heavy mineral oil should be used also for soaking or impregnating cores during or after manufacture, or when the rope is being laid up.

Batching and impregnating oils used in manufacturing the cores of wire ropes, says this bulletin, do not decompose in practice enough to cause appreciable corrosion of the ropes in which they occur; on the contrary, they protect them. Oils may become darkened by dusts such as those of coal and iron oxide without losing their protective value. They are still serviceable so long as they are not squeezed out of the rope. Ropes can be corroded internally even when external water containing harmful salts and acids is not able to penetrate to the core. Manila and some other core fibers may contain or may develop formic and acetic acids as a result of bacterial action; these will corrode wire ropes in the presence of moisture even where oxygen is absent.

Pressure between wire and core removes protective oils and increases contact between fiber and steel, and thus tends to accelerate the rate of acid attack. The intensity of bacterial action is not uniform and hence corrosion is distributed unevenly. Cold-water treatment will remove most of the harmful acid in raw manila fiber, and subsequent bacterial action possibly might be prevented by treating the washed fiber with an antiseptic which would not corrode steel; but these methods have not been tested in practice, declares the bulletin.

Iowa Coal Studies, by H. L. Olin and others. Iowa Geological Survey. Technical Paper No. 3; 80 pp., 3¾x8½ in.; paper.

Excellent work in the promotion of better practices in the Iowa coal fields is being done by the State University of Iowa under the leadership of Dr. Olin. Of interest in general is his use of a mixture of aluminum sulphate (now quoted at $1.35 to $1.50 per hundred pounds) and calcium carbonate with coal to produce in contact with moisture a slow evolution of carbon dioxide.

A 300-ton test pile of untreated Appanoose County run-of-mine coal crushed to minus 2 in. and another of treated coal of the same origin and size but containing only 150 tons were laid down in April of last year. They were packed down only moderately close and provided with thermocouple leads for noting temperature rises. During the summer neither approached the danger point. But in the autumn "the untreated pile began to show signs of fever," and on Sept. 23 a heavy drenching with water was needed to prevent the development of a fire. The treated pile, on the other hand, was cooler in late September than it had been on occasion in August and was evidently in condition for a winter's run. The chemical mixture was applied at the rate of 1.5 lb. per ton of coal at an estimated cost of 3.5c. per ton treated.

With better preparation Dr. Olin believes Iowa coals would be regarded with greater favor. The studies show what can be done to improve Iowa coal, the use of the coal of that State in the Paragon Kol-Master stoker and the carbonization of Iowa coals; they coke if, when rapidly preheated to near their fusing point, they are then quickly transferred to a heated retort. Studies are described of the agglutinating indexes of the coals of the State, their disintegrating characteristics, and their rank as determined by permanganate numbers.

Geology and Fuel Resources of the Southern Part of the San Juan Basin, New Mexico: Part 3—the La Ventana-Chacra Mesa Coal Field, by C. H. Dane. U. S. Geological Survey. Bulletin 860-C, 172 pp., 4 pocket plates; paper. Price, 40c.

Located on the Continental Divide, the San Juan River coal field, as usually described, covers coal areas on rivers which run in all directions. It is generally regarded as covering Gallup, though the town and coal area bearing that name are on the Rio Puerco (of the West) and not on the San Juan River, both, however, being tributaries of the Colorado River. But La Ventana is on another Rio Puerco which runs into the San Jose and eventually reaches the Rio Grande and the Gulf of Mexico. The Chacra Mesa is adjacent to the Chaco River—a branch of the San Juan.

Coal is found in Mesaverde and Fruitland formations of the Upper Cretaceous period. The beds in places abound in woody charcoal fragments and have locally many small irregular clear reddish-yellow lumps and grains of fossil resin. The fuel is of fair quality but high in moisture and often badly burned at the outcrop. Coal is being, or has been, mined at several points in this area; its thickness reaches as much as 6 ft. 1 in.

Coal Deposits of Pike County, Kentucky, by C. B, Hunt, G. H. Briggs, Jr., A. C. Munyan and G. R. Wesley. U. S. Geological Survey. Bulletin 876; 92 pp., with separate portfolio of 48 maps and cross-sections. Price, $2.25.

With coal running up in one case—a 5.6-per-cent-ash cannel—to 14,960 B.t.u. (Upper Elkhorn No. 2 coal bed with 4 in. of block coal excluded), Pike County, Kentucky, shows coals almost everywhere of consistently high thermal value as well as of high ash-softening temperature (2,940 deg. F. maximum), low-sulphur (0.4 per cent minimum), high hydrogen (up to 6.1 per cent), and low ash (down to 1.6 per cent).

There are thirteen valuable coal beds which have been mined for interstate shipments. Usually they run from 4 to 5 ft., but locally exceed the larger figure. In addition, there are at least 48 other coal beds, generally thin but locally thick enough to be mined under present economic conditions. This bulletin embraces the geography, geology, structure and geomorphology of the region and discusses its several coal beds.

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With Exide MIPOR Separators
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"Doesn't haulage become a bottle-neck in a mechanized operation?"

"It could, but it won't if you use storage battery locomotives and equip them with Exide-Ironclad Batteries"

"Here's the point. You have to get loaded cars away from the loading machine and keep empties coming in. It's a kind of fast shuttle service, and storage battery locomotives are ideal because they accelerate fast and instantly respond to the controls with full power. Exide-Ironclad Batteries have the reserve power and dependability to make such a plan effective."

THE problems of mechanized mining have emphasized anew the peculiar advantages of Exide-Ironclad Batteries in underground haulage. Their high power ability gives them tremendous reserve power. Their high "afternoon" voltage means good sustained haulage speed all day. They are trouble-free, dependable, easy to maintain, and commonly deliver years of low-cost service. Write for free booklet, "The Storage Battery Locomotive for Underground Haulage."

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

OPERATING IDEAS

From Production, Electrical and Mechanical Men

Dipper Salvaged by Welding At Total Cost of $200

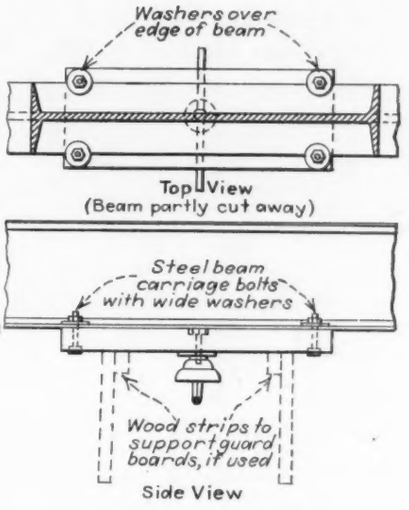
Salvaged by welding after being broken in service, a 7½-cu.yd. dipper since has been used for over two years on a Marion 300 shovel of the Standard Brazil Block Coal Co., Clay City, Ind., with few signs of the wear and tear of such service. The dipper was broken in two places. One of the breaks ran the full length of the bucket. Repairs were made in 26 hours, and the cost was but a fraction of the cost of a new dipper.

Figs. 1 and 2 show the dipper before and after repairs. One of the two major breaks shows plainly in Fig. 1. The other break, just as bad, was between the two hinges, where a metal plate can be seen in Fig. 1 temporarily holding the parts together. Repairs were made at the Linton (Ind.) Electric Welding Works. The operator first cut away metal along each side of the breaks with a cutting torch to assure a clear metal surface. Then, using the electric arc, he deposited a series of stringer beads of weld metal overlapping each other approximately 1/16 in. These beads extended the full length and width of the break on either side and assured a good bond with the base metal of the dipper.

As the next step the two lips of the dipper were pulled together and the first junction weld was made. Like the stringer beads, this weld was made with 3/16-in. Lincoln "Stainweld A" electrodes. The junction weld was peened thoroughly and then the gap was finish welded with 3/16-in. Lincoln "Manganweld" electrodes made especially for welding manganese steels. Peening was done between each pair of beads to facilitate compacting the metal during cooling. The welds were free from cross checks and required no machining. Total cost of the repairs was $200.

Trolley Catching on Beams Stopped by Wooden Guard

Wooden guard boards are fastened to the bottoms of steel I-beams used to support the roof over haulageways at the Cochran No. 1 mine, Cochran Coal Co., Salina, Pa., writes Anthony Shacikoski, foreman. These guards eliminate the hazards which occur when the trolley pole on a locomotive jumps the wire and the harp or wheel catches on the edge of the beam, with the result that the pole is broken or the beam is pulled out, depending upon which is the weaker. The guards also reduce the possibility of the wire, if loose, being pushed against the beams by the trolley wheel, with resultant arcing and charging of the beams.


Washers over edge of beam
Top View
(Beam partly cut away)
Steel beam carriage bolts with wide washers
Wood strips to support guard boards, if used
Side View

Details of I-beam guard

The guard consists of a short length of board about 1½ in. wider than the flange of

Fig. 1—Dipper breaks before welding

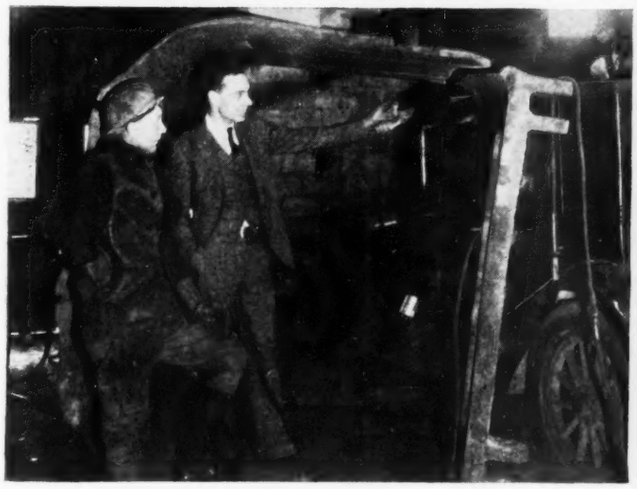
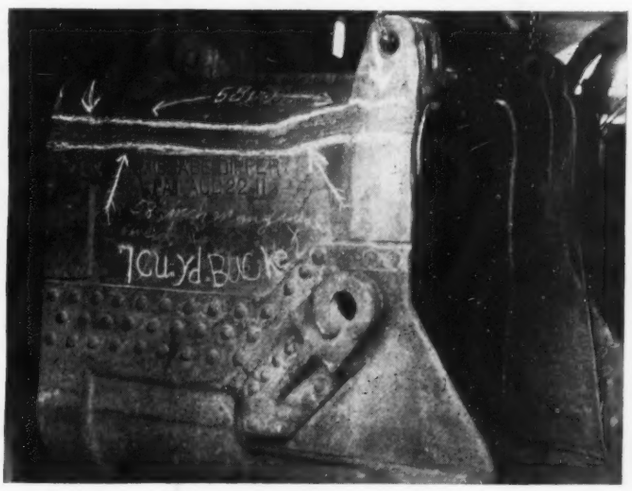


Fig. 2—Dipper welding completed

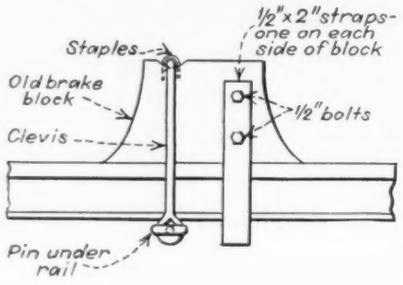


the I-beam. Holes are bored near the edges, as indicated in the accompanying illustration, to permit fastening the board to the beam. An additional hole in the center accommodates the carriage bolt used to hold the hangar insulator, when necessary, in place. Carriage bolts also are used to fasten the guard to the beam. Nuts are placed on the top of the I-beam flange, with large washers under them. These washers grip the flange and hold the guard in place. In installing the guards, the nuts are tightened so that the bolt heads are drawn up into the wood, leaving the bottom surface of the guard smooth. In case guard boards for the trolley wire are to be installed, narrow strips of wood are mounted on the beam guards as indicated in the sketch.

Old Brake Block Makes Safety Car Stop

Old wooden brake blocks of the type shown in the accompanying illustration are used at the suggestion of Harry Moore, electrician, in making safety car stops at the mine of the Ajax Coal Co., Emoryville, W. Va. Details are supplied by Walter Iman, mine foreman. In making the stop, the brake block is turned upside down and notched to receive a clevis, which is held in place by a large staple. By running a pin through the eyes of the clevis and under the rail, the block is fastened in operating position. Two ½x2-in. irons are placed on either side to complete the block. The irons are held in place by ½-in. bolts, and extend down below the rail to rest against the tie.

Safety-block construction details



Safety Gate Protects Miners Negotiating Manways

To protect miners from falling material while they are ascending or descending the manways in heavily pitching seams, one anthracite organization employs the safety gate shown in the accompaning illustration. Such gates are used in all places where the pitch exceeds 45 deg.

Material used in constructing the gate is the common hardwood manway plank split to a width of not greater than 4 in. Two of these pieces serve as uprights, and as many others as are necessary are placed crosswise to form a gate, keeping approximately a 6-in. opening between the crosspieces to permit the free circulation of ventilating air to the working face. Pieces are nailed firmly together and the gate is carried up the manway by the miners and installed on the second prop below the face. The gate is advanced as the breast is driven up the pitch and always kept on the second prop below the face. In the open position the gate is fastened back to the "gob box," in closed position, one side rests on the "gob prop" and the other on the "rib prop" or, in the absence of a rib prop, against the rib, with a slight angle from the prop to the rib to prevent any possibility of the gate being pushed through by a rush of coal from the face.

The safety gate is used as follows: When firing in the breast above the downcast manway the gate in this manway remains in the open position while the gate over the upcast manway is closed to prevent any lumps of coal from coming down the upcast manway after a blast. The pieces of coal thrown on the gate by the blast are lifted off by the miners, and the gate is opened and placed in position against the gob box. When firing above the upcast manway the gate remains open and the gate over the downcast manway is closed.

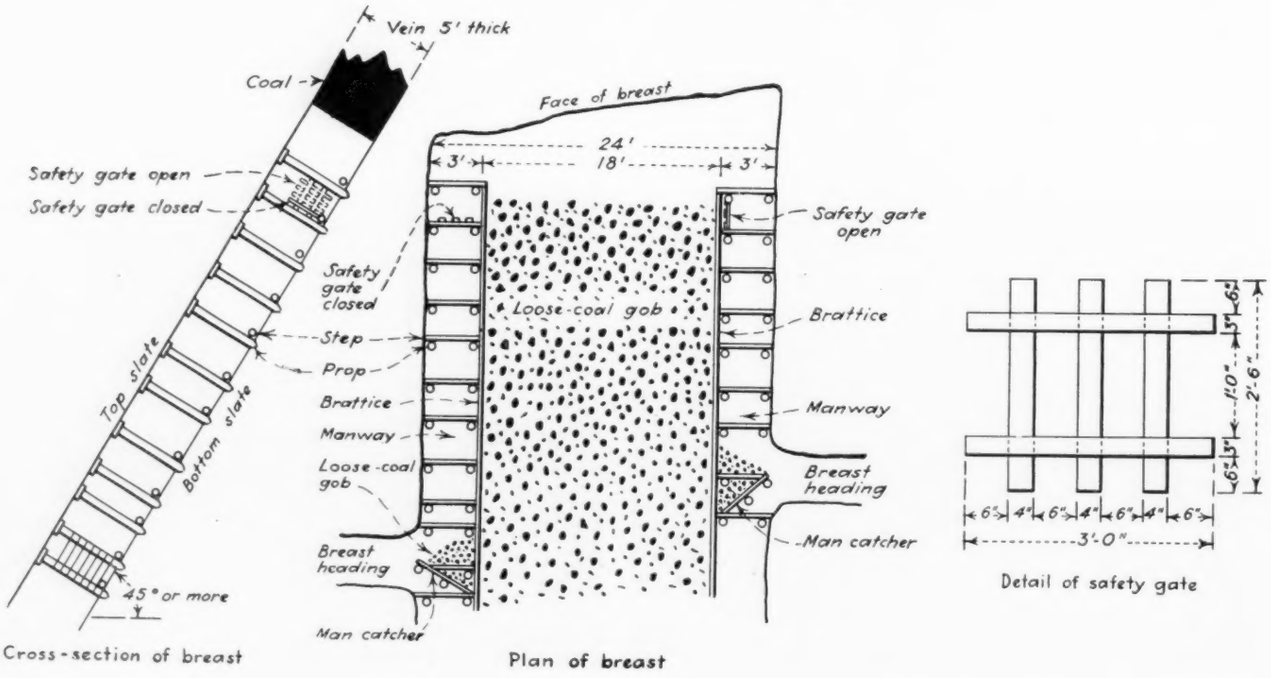
After the shift is over, the miners close

Reciprocity

• Operating, electrical, mechanical and safety men who follow these pages from month to month should avoid considerable wasted effort in discharging their daily tasks. The problems they face have been or are being faced by their neighbors or men in some distant fields. Somewhere, someone has solved practically every problem that comes up around a coal mine, or will solve it when it does come up. These pages are designed to present the best of those solutions. If you have gained something from them, it is only fair that you should reciprocate with an idea of your own. So send it in, with a sketch or photograph if it will help to make it clearer. For each acceptable idea, Coal Age pays $5 or more on publication.

★ ★

Construction and installation of manway safety gate



Communications and Coal-

Must Flow Smoothly!

VITAL to the ebb and flow of world commerce—to modern civilization itself—are these flimsy threads of communication emanating from countless switch-boards over the face of the globe. Just as vital to the mine operator—to the smooth flow of tonnage in his mine—is properly functioning locomotive equipment. For upon the shoulders of the locomotive and its affiliated equipment rest the responsibilities of transporting the coal to tipple or breaker.

Mine operators—wise in the ways of coal haulage—have long specified O-B headlights, trolley wheels, shoes and harps and wire conditioners as standard equipment. Experience with these O-B products have given them confidence in their performance—assurance of low-cost haulage. They know, too, that when ordinary mine materials are on their way to the scrap heap, O-B products are still on the job functioning at peak efficiency.

If you're looking for locomotive equipment that spells low cost operation, continuous tonnage flow and extra profits—*specify O-B.*

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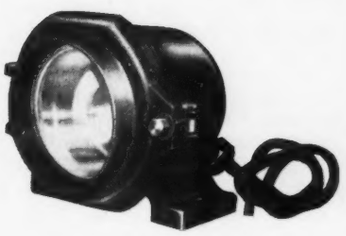
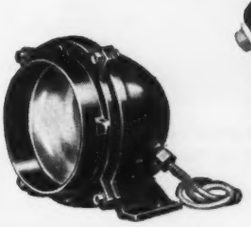
O-B's Extra Life Brings You An Extra Profit

Longer wire and shoe life result from use of this wire conditioner

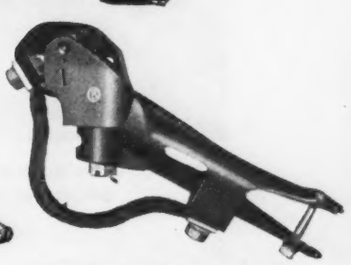
O-B 6-inch wheels are exceptionally long-lived



For gathering haulage—Type MB Headlight



For powerful main haulage illumination—Type MSS Headlight



For heavy duty service—Heavy Duty Mine Harp and Shoe

the safety gates on both the upcast and downcast manways. The gates, being closed in this manner, protect the fireboss when he makes his early morning inspection before the miners report for work and also protect the miners going to the face at the start of the shift. Should the face of the breast start to run, which happens at times in heavy pitching seams of coal, making it necessary for the miners to leave the face and hurriedly go down the manway to the first crossheading to avoid being caught in a rush of coal, the miners on their way down will close the manway gate, thereby protecting themselves from any material falling from above.

Hints From a Shopman's Notebook: Reclaiming Shortwall Frames

By WALTER BAUM
Master Mechanic, Perry Coal Co.
O'Fallon, Ill.

TO reclaim the main frames (No. 30240) on Goodman 12AA shortwall mining machines after they had been discarded because of worn bearing housings, I found it necessary to develop the jig described in the following paragraphs. This reclamation involved building up the worn places by electric welding and then boring them out to the proper size to accommodate Bushings Nos. 54577, 54576, 54580 and 83932, all with an outer diameter of 2.941 in. Points where the work was necessary are indicated by the arrows in Fig. 8.

Before reboring the frame, it was necessary to try to get the original alignment. I started by measuring from the machined surface (indicated by the arrows in Fig. 8) to the bottom of the frame and also measuring the width. Two plates, *A* and *B* in the accompanying illustrations, then were cut out of mild steel. Dimensions were 1½x8x34 in. These plates were laid on the lathe carriage and marked at the T-slots. Four holes were drilled in each plate and counterbored to hide the nuts. By measuring from the lathe center to the top of the lathe carriage, I was able to figure out the height of the spacers (Fig. 1) to be used under plates *A* and *B*, which was 2$\frac{7}{16}$ in. on the lathe I used. These spacers brought the tops of Plates *A* and *B* up to within 3$\frac{1}{32}$ in. of the lathe center.

To make a bearing support for installation on Plate *B*, two pieces of mild steel, one 1½x5$\frac{1}{4}$x5$\frac{3}{4}$ in. and the other 1½x3$\frac{3}{4}$x5$\frac{3}{4}$ in., were welded together and to Plate *B* as indicated in Fig. 1. After installation, the bearing support was drilled and bored out to 2$\frac{3}{4}$ in., using a short boring bar.

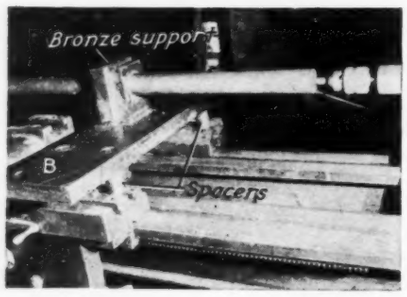


Fig. 1—Showing method of drilling boring-bar centers

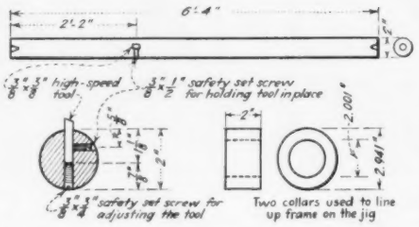


Fig. 2—Details of boring bar and collars

Then a piece of bronze 3 in. long that had been turned to an outer diameter of 2.7520 in. was pressed in the support, using a bolt and plates. Next the bronze bushing was bored out to 2.004 in., or 0.004 in. larger than the bar used for boring the frame. The edges of Plate *B* were cut out as in Fig. 4 to clear the frame. Plate *A* (Figs. 4 and 5) was drilled the same as *B* and was bolted to the lathe carriage with spacers as in the case of *A*. All holes in Plate *A* were counterbored and countersunk, as also was done in the case of Plate *B* when necessary to clear the frame.

With the machining completed on Plate *B* and Plate *A* in place, the boring bar was made as in Fig 2, along with two steel collars 2 in. wide with inner diameters to fit the boring bar and outer diameters of 2.941 in., or the same as the bushings. The boring-bar centers were drilled as in Fig. 1. The lathe carriage was run to the back end of the lathe, and with one end of the bar in the bushing in the bearing support on Plate *B* and the other held as true as possible in the lathe chuck, one end of the bar was centered. Next the other end was centered in the same manner.

Upon completion of the boring bar, the frame was lifted with chain blocks and placed on Plates *A* and *B*, the opening back of the vertical bearing housing in the frame slipping over the bearing support on Plate *B* (Fig. 3). The tailstock was removed from the lathe and the boring bar was run through the Plate *B* bearing and the frame opening noted in the preceding sentence. The two collars were placed on the bar and the tailstock was replaced. With the bar held on the lathe centers, the frame was moved so that the collars would just clear the sides of the bearing surface in the frame that showed the least wear.

Vertical movement of the frame was accomplished by four ¾-in. leveling screws in holes drilled in Plates *A* and *B*, one in each end of each plate, as indicated in Figs. 4 and 5. When the distance from the machined surface of the frame to the top of the boring bar, as measured with a height gage, was 1 in., the frame was clamped to Plates *A* and *B* as in Fig. 3.

Two large angles (*C* and *D*) 20½ in. long were then cut out as in Fig. 4. Each was drilled with five holes to accommodate the bolts shown in the same figure. By means of an additional bolt through the other legs, the angles were clamped to the guide, or tongue, on the underside of the frame, after which the locations of the holes were marked on Plate *B* to correspond with those in the angles. Next two ⅝x3½x4-in. angles 21 in. long were clamped to Plate *A*. These angles are set over slightly from the center of the plate to clear the sheave pin, and one angle is cut out as in Fig 6 to clear the sheave itself. After the angles are clamped, the locations of the holes previously drilled are marked on Plate *A*, as well as the hole in one of the angles to make it possible to use spacers for making the frame support the boring-bar bearing on Plate *A* and thus prevent movement of this bearing support on the plate while boring. The frame is then removed and the holes are bored in plates *A* and *B* for bolting on the angles. In drilling Plate *B*, a ⅜x8x14-in. spacer plate (Fig. 4), made necessary by a shoulder on the bottom of the frame, is drilled at the same time. When installed, this spacer plate makes the distance between the top of Plate *B* and the top of angles *C* and *D* (Fig. 4) 1⅛ in.

When the angles are bolted to Plate *A*, the boring-bar support on this plate is bored out and bushed in substantially the same manner as in the case of the support

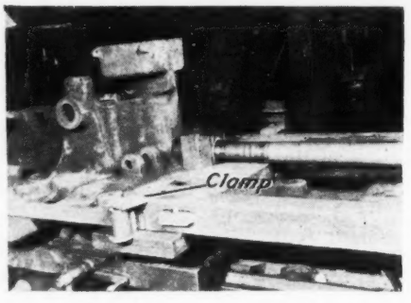


Fig. 3—Showing bottom half of frame with boring bar in place

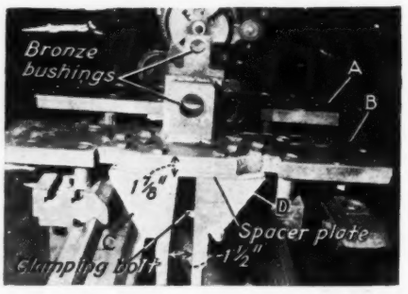


Fig. 4—View of jig from tailstock end of lathe, showing Plate B construction details

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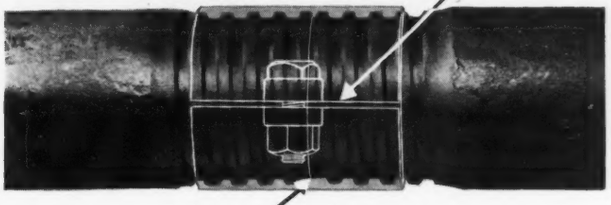
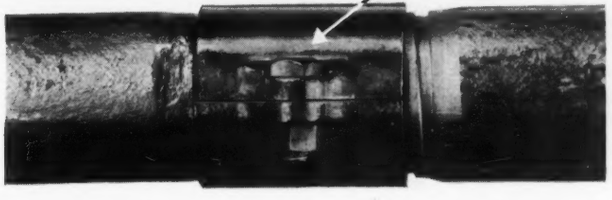


2. Ends meet solidly and asphaltic pipe lining freezes sections together, forming an absolutely water-tight seal.
3. Adjustable bolt *closes slot in coupling,* giving a positive tight joint.



4. To take apart, simply loosen bolt and pipe can be rapidly unscrewed and disassembled.

HERE'S new protection for users of Bermico Fibre Pipe. A coupling that actually grafts one pipe section to another! And that can be assembled without the use of heavy, hard-to-handle tools.

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Add to Bermico's permanence the savings its light weight allows on freight and trucking rates and you know why it pays to specify Bermico. BROWN COMPANY, Portland, Maine.

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on Plate *B*, with the exception that the brass bushing has a length of 2 rather than 3 in. As the angles on which the support is bolted are installed off center on Plate *A*, it is necessary to set the bushing over far enough to bring its center in line with the lathe centers. To locate the hole in the support, Plate *A*, with the angles and support in place, is bolted to the lathe carriage, using the spacers described above. A drill is substituted for the center in the lathe spindle, and with the lathe in motion the carriage is run up so that the drill is against the bearing support. A small drill

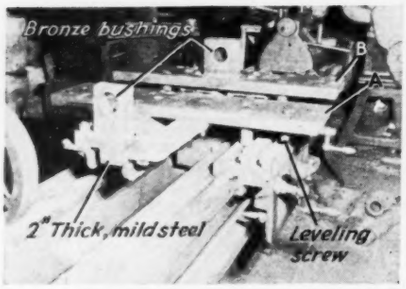


Fig. 5—View of jig from spindle end of lathe, showing Plate A construction deta ls and second boring-bar-bearing support

Fig. 6—Showing adjustable spacer used to make frame support boring-bar bearing

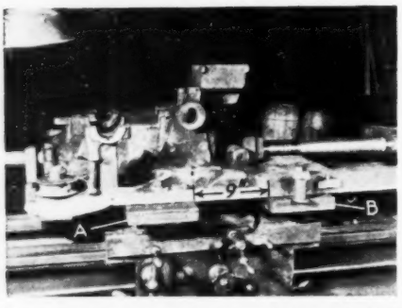


Fig. 7—Casting in place on lathe, showing front and rear boring-bar bearings

is used first, followed by larger drills until the hole is 1¾ in. in diameter. Finally, a short boring bar is used to finish the hole, and the bronze bushing is pressed in place and drilled and bored to size.

Exact-sized holes are drilled in the angles and plates so that the angles will stay in position when bolted up. When such bolting up is completed, the jig is put back on the lathe and lined up. In this operation, the tailstock is removed and the boring bar is placed in the bearings. Then the tail-

Fig. 8—View of machine frame, with arrows indicating worn places

stock is replaced and the bar is placed on the lathe centers. The bolts in Plates *A* and *B* (9 in. apart), which come up from the T-slots in the lathe carriage, then are tightened, the bar being turned meanwhile to prevent binding.

In building up the bearing surfaces in the top and bottom castings making up the machine frame, a piece of ¼x¾-in. copper of the same length is placed in the keyways in the bottom half of the frame (Fig. 8), after which the welding is done on each side. The surface designated by *X* in Fig. 8 also is built up, even though there is no bearing at this point, as it is the only place where measurements can be taken while the casting is being bored. An inside caliper is used for measuring the hole, as the boring bar is in place all the time and there is only about 2 in. of space between the casting and the boring-bar bearing for measuring.

After the worn places are built up, the top half of the frame is bolted to the bottom and the entire assembly is placed on the jig. The two angles on Plate *B* take the tongue mentioned above, automatically assuring alignment on this plate. Bolts passing through holes in the frame (Fig. 7) assure proper positioning on Plate *A*. The height is adjusted, if necessary, by means of the adjusting screws mentioned above, after which the frame should be in line in all directions and ready for boring after the spacers are installed as in Fig. 6 to assure the proper relationship between the frame and the bearing support on Plate *A*, which is bolted to the supporting angles after the frame and boring bar are in place.

I have taken the jig off and put it back on the lathe eight times and have had no trouble getting the frames to line up. Also, none of the eight frames has given any trouble in service.

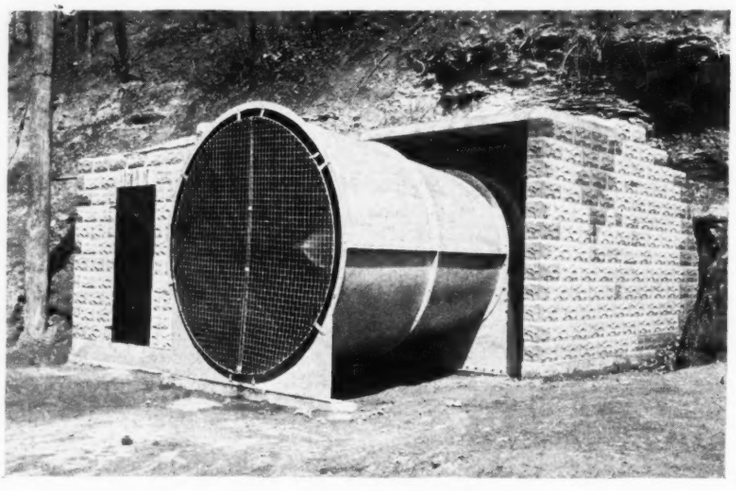
Air Increased 44 Per Cent Without Power Change

Increasing the volume of mine air was one of the first improvements made by the Lillybrook Coal Co. when it purchased and took over operation of the Killarney (W. Va.) No. 3 mine, formerly owned by the Killarney Smokeless Coal Co. Installation of a new fan to replace the original plain-bearing centrifugal provided the necessary increase in volume without an increase in electric-power consumption.

The new fan, a Jeffrey 6-ft. Aerodyne unit, operates at 850 r.p.m. and delivers 65,000 c.f.m. at a 2.4-in. water gage. The fan is driven by a 30-hp. 440-volt induction motor through V-belts. The power input is 25 hp., the same as was required by the old fan, which forced but 45,000 c.f.m. through the mine. Anti-friction bearings (SKF roller type) provide a dependability not assured by the old fan. Maximum rating of the new unit is 100,000 c.f.m. at a 5-in. water gage, which delivery would require 100 hp.

J. W. Ailstock, general superintendent of the Lillybrook mines, is especially pleased over the low cost achieved in installing the new fan. Labor and material (fan cost not included) totaled less than $500.

Installation in a complete new building required less than $500



WORD FROM THE FIELD

Preparation and Safety to Be Coal Division Themes

Preparation and safety will have prominent places at the two-day meeting of the Coal Division, A.I.M.E., to be held Oct. 27 and 28 at the William Penn Hotel, Pittsburgh, Pa. The division will meet jointly with the Fuels Division of the American Society of Mechanical Engineers. In addition to several inspection trips the following papers will be on the Coal Division program:

"Economics of Preparing Coal for Steam Generation," H. F. Hebley, Commercial Testing & Engineering Co.; "The Chemical Treatment of Coal and Coke," P. Nicholls, U. S. Bureau of Mines; "Fundamental Factors Involved in the Dustproofing of Coal," M. F. Fife, Mellon Institute of Industrial Research; "Theoretical and Practical Aspects of Segregation in the Handling of Coal," D. R. Mitchell, University of Illinois; "Statistical Interpretation of Laboratory Coal Tests and Sampling Methods," G. B. Gould, president, Fuel Engineering Co. of New York; "Effective Methods of Eliminating Gas Ignition in Coal Mines," W. B. Hillhouse, chief, Alabama Department of Mines; "Inspection and Safety of the Island Creek Properties," A. J. Bartlett, Island Creek Coal Co.; "Observations on Nova Scotia Mining Practice," T. L. McCall, Dominion Steel & Coal Corporation.

Themes to be discussed by the Fuels Division, A.S.M.E., include: "Selection of Coals for Pulverizers," B. E. Tate, National Cash Register Co.; "Underfeed Stokers," J. E. Tobey, Appalachian Coals, Inc.; "Chain or Traveling-Grate Stokers" (both bituminous and anthracite), G. A. Anbro, Colgate-Palmolive-Peet Co.; "Small Underfeed Stokers" (less than 150 lb., both bituminous and anthracite), engineering committee, Stoker Manufacturers' Association, G. M. Guthrie, chairman; summary of papers on "Coal Utilization in Relation to Coal Research," Ralph E. Sherman, Battelle Memorial Institute.

Charles F. Hosford, Jr., chairman, National Bituminous Coal Commission, will be the principal speaker at the banquet on Oct. 28.

Alabama Mine Under Way

The start of construction of a permanent preparation plant and other mine structures and buildings at a new operation at Lindbergh, Ala., has been announced by the Brookside-Pratt Mining Co., which has been carrying on preliminary development work for some time. Preparation equipment will include two Jeffrey diaphragm jigs with a capacity of 60 tons per hour each and two Deister Plat-O tables with a capacity of 15 tons per hour each. Two additional tables are planned later as production increases to the expected ultimate of 1,000 tons per day.

A drift opening at the new mine gives access to the Pratt seam, averaging about 32 in. in thickness, which is primarily a steam producer. The output will be mined by the longwall system, using undercutting machines and mechanical loaders to place the coal on conveyors which will carry it to car-loading points on the headings. Car capacity is 2 tons, and electric locomotives will be installed for haulage. A spur of the St. Louis & San Francisco R. R. serves the mine. Brookside-Pratt, with several other operations in the district, is headed by A. R. Long, Birmingham.

Keeping Step With Coal Demand

Bituminous Production

Week Ended	1937 (1,000 Tons)	1936* (1,000 Tons)
August 7	7,380	7,634
August 14	7,640	7,775
August 21	7,611	7,671
August 28	7,943	8,034
September 4	8,400	8,279
Total to Sept. 4	300,548	276,116
Month of July	**31,912**	**32,005**
Month of August	**33,665**	**33,086**

Anthracite Production

August 7	428	653
August 14	548	655
August 21	475	708
August 28	748	1,143
September 4	830	738
Total to Sept. 4	33,206	37,295
Month of July	**2,661**	**3,925**
Month of August	**2,584**	**3,593**

* Outputs of these two columns are for the weeks corresponding to those in 1937, although these weeks do not necessarily end on the same dates.

Bituminous Coal Stocks

	(Thousands of Net Tons) Aug. 1, 1937	July 1, 1937	Aug. 1, 1936
Electric power utilities	8,523	8,457	5,473
Byproduct coke ovens	7,433	7,770	5,302
Steel and rolling mills	1,488	1,540	916
Railroads (Class 1)	7,197	7,701	4,254
Other industrials*	12,359	12,268	7,781
Total	37,000	37,736	23,726

Bituminous Coal Consumption

	(Thousands of Net Tons) July, 1937	June, 1937	July, 1936
Electric power utilities	3,843	3,505	3,564
Byproduct coke ovens	6,281	5,788	5,332
Steel and rolling mills	1,042	982	1,011
Beehive coke ovens	450	439	177
Railroads (Class 1)	6,760	6,653	6,501
Other industrials*	9,399	10,000	8,365
Total	27,795	27,367	24,950

* Includes coal-gas retorts and cement mills.

Report Holds Unity Vital to Hard-Coal Rehabilitation

Only by unified action of various factors in the industry is there hope of beneficial results from any program of rehabilitation of the anthracite industry, according to a report on the marketing situation by the so-called bootleg commission appointed by Governor Earle to study conditions in the hard-coal field with a view to remedying abuses and reclaiming lost markets. The marketing report, which was prepared under the direction of Prof. Richard R. Mead, of the University of Pennsylvania, was begun last March and was completed on Sept. 10, according to W. Jett Lauck, chairman of the commission. A report on bootleg mining also was released on Sept 13, and one on anthracite lands and deposits on Sept 20. The chairman stated that as other sections of the report were completed they would be released to the public pending printing of the general report.

Pointing out that the two chief competitors of anthracite are bituminous coal and fuel oil, the marketing report emphasizes that the consumption of fuel oil is based upon convenience rather than price, and adds: "The anthracite industry should, therefore, sponsor the sale of automatic equipment designed to burn only anthracite if the rapid growth of oil is to be checked." Other conclusions developed are:

"Anthracite at present finds its market practically limited to domestic and commercial consumers in the New England and Middle Atlantic States. There is still a large price differential in favor of bituminous coal in the West and South and it is unlikely that anthracite will ever regain much of its lost tonnage in these areas.

Cites Broad Price Spread

"The present price structure for anthracite is unsound. While the prices of the domestic sizes may be too high, the low prices received for the steam sizes make further reductions in the mine price of the domestic sizes impossible if the producing companies are to continue to operate on a sound financial basis. The differences in the recovery of steam and domestic sizes in the various anthracite producing regions, together with the desirability of encouraging the sale of anthracite-burning equipment, make it essential that steps be taken to reduce the spread between the prices of these two groups of sizes.

"Freight rates and distribution margins represent approximately one-half of the prices which the domestic consumer pays for his coal. Reductions in such costs will prove beneficial to the industry, especially in those more distant areas where bituminous coal has enjoyed a strong competitive position because of the lower price.

"No effective program of marketing can

be developed unless price cutting and other internal competitive practices are eliminated.

"Unified action is vital to any program of rehabilitation for the industry. While it is questionable as to how much such action will reduce costs to the consumer, it will enable the industry to more effectively distribute its product and render better service to its consumers.

"A well-planned program initiated at once may lay the foundation for expansion in the future. The present promotion organization with enlarged financial resources and the united support of the entire industry might well serve as a nucleus for such a program. Unless the anthracite industry exerts every weapon at its command to combat the activities of a powerful competition, further declines in the consumption of anthracite are inevitable."

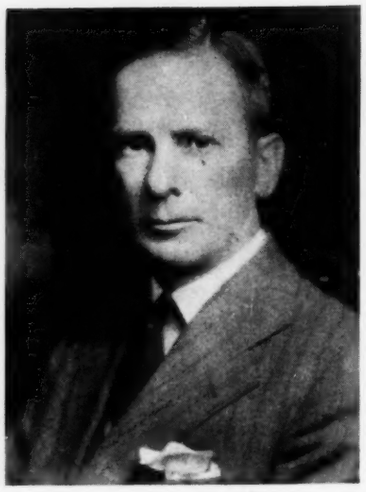
The bootlegging report, prepared under the direction of Commissioner James W. Angell, assisted by P. Bernard Nortman, director of research, alleged that illegal mining was considerably less extensive than was indicated by early press reports. In 1936-7, according to the report, approximately 13,000 men were engaged in illegal mining, consisting of 7,000 working in bootleg holes, 2,000 in picking over old culm and refuse banks, 1,300 in bootleg breakers, and 2,700 in trucking (many of whom also performed other kinds of trucking). In the same period the outlaw operators produced and sold their output at the rate of 2,400,000 tons a year, final consumers paying roughly $16,000,000 annually for the product; output in the peak year 1935 hardly reached 2,900,000 tons.

The preliminary report offers no solution for the bootleg problem, the commission believing that any permanent solution is necessarily dependent on the rehabilitation and recovery of the whole anthracite industry. Ad interim reports by the commission, it announces, explored a number of possible steps to this end, and in its final report it proposes to present definite conclusions. It is pointed out also that the gradual exhaustion of the coal deposits that are easily accessible from the surface, the increasing severity both in Pennsylvania and other States of legal restrictions on the trucking and sale of bootleg coal, and the slowly improving prospects for a genuine revival of the whole legitimate hard-coal industry seem to forecast a gradual decline of bootlegging in future years.

Foresees Control by Few Firms

Prepared by C. V. Maudlin, director of the Bureau of Applied Economics, Washington, D. C., the report on anthracite lands and deposits states that, on the basis of estimates of federal authorities, the theoretical life of recoverable anthracite is 175 years, with production at the average rate of output in 1934-6; on the basis of estimates by operators' engineers the life would be about 93 years. If the present rate of production is continued for 25 years, however, all the remaining recoverable anthracite will be owned by six companies, and a few years later it will be concentrated in the hands of four companies.

To prevent eventual domination of the industry by a few companies and greatly increased cost for anthracite by reason of the burden of carrying reserves, the report urges that it is desirable that ownership and control of excess reserves be divorced from the producers and handled under either private or federal ownership.



J. P. Williams, Jr.
President, National Coal Association

"Of the various plans suggested for accomplishing such a separation," says the report, "the most practical one and the one of greatest benefit to all parties concerned is based on the Commonwealth of Pennsylvania obtaining ownership and control of the lands containing the excess recoverable anthracite through their purchase by the issuance of 50-year 3 per cent bonds on a discount basis."

New Preparation Facilities

CLINCHMORE COAL MINING CO., Clinchmore, Tenn.: contract closed with Morrow Mfg. Co. for crushing and rescreening plant, including picking table, conveyors, vibrating screen and crusher (to be furnished by the coal company); capacity, 125 tons per hour.

KELLYS CREEK COLLIERY CO., Maidsville, W. Va.: contract closed with McNally-Pittsburg Mfg. Corporation for tipple and cleaning plant to produce five primary sizes and mixtures thereof, including a McNally-Norton automatic washer with a capacity of 250 tons per hour for 5x⅜-in. coal; over-all plant capacity, 350 tons per hour.

MINERAL SPRINGS COAL CO., West Pittston, Pa.: contract closed with Finch Mfg. Co. for three 10-ft. Menzies cone separators for Mineral Springs breaker. Each unit will have a feed capacity of 110 tons per hour, making the total capacity 330 tons per hour. One unit will clean egg and stove; another, chestnut and pea; and the third, rice, barley and No. 4 buckwheat. Installation is to be completed about Nov. 1.

DAVID E. ROWLAND, Cuba, Ill.: contract closed with Morrow Mfg. Co. for five-grade screening plant serving truck-trade storage bins at Rowland strip mine. Equipment includes reciprocating plate feeders, mine-run conveyors, crusher, shaking and vibrating screens and loading booms from screens to storage bins and from storage bins to trucks and rescreen conveyors. Capacity is 150 tons per hour.

STONEGA COKE & COAL CO., Derby, Va.: contract closed with Morrow Mfg. Co. for blending plant for Derby mine consisting of track hoppers, feeder elevator and conveyors and steel storage bins for 1½-in. x 10-mesh or ¾-in. x 10-mesh coal; capacity, 100 tons per hour.

N.C.A. Convention Plans Nearly Completed

Plans for the twentieth annual meeting of the National Coal Association, to be held Oct. 7 and 8 at the Hotel William Penn, Pittsburgh, Pa., are rapidly nearing completion, according to J. P. Williams, Jr., president. Topics of paramount importance to the industry will be covered in the program, which includes the following: "Looking Forward," Charles F. Hosford, Jr., chairman, National Bituminous Coal Commission; "Stokers—Your Fighting Ally," J. E. Martin, manager, stoker division, Link-Belt Co.; "Coal Research," H. H. Lowry, director, Coal Research Laboratory, Carnegie Institute of Technology; "The Relation of Home Building to Coal Sales," Howard S. Davidson, *Better Homes and Gardens;* "Federal Taxation vs. Business Enterprise," F. H. Clausen, president, Van Brunt Manufacturing Co.; the future of marketing agencies will be discussed by spokesmen for Appalachian Coals, Inc.; Alabama Coals, Inc., and the Smokeless Coal Corporation.

Mr. McConnell will preside at the annual dinner, to be held in the evening of Oct. 7, with J. B. Hill, president, Louisville & Nashville Ry., as toastmaster. Inspection trips to coal-cleaning and other industrial plants in the vicinity have been arranged for the afternoon of Oct. 8. There also will be a luncheon for secretaries of district coal operators' associations on the day preceding the opening of the annual meeting, to be followed by a discussion of association activities.

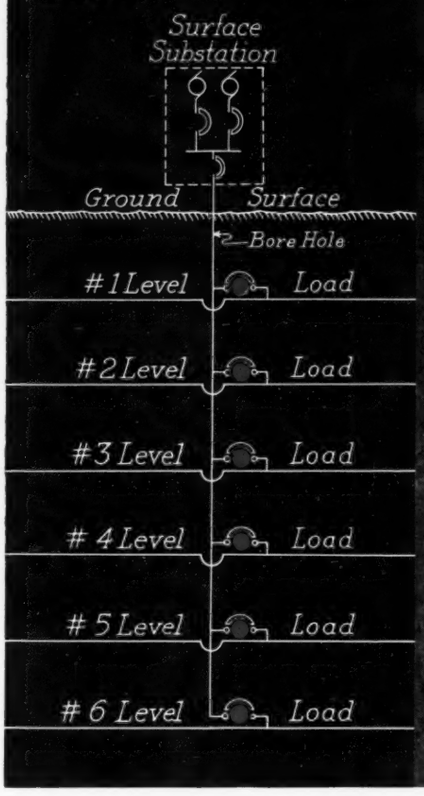
A local committee has been named to assist the general meeting committee in preparations for the reception of operators from all parts of the country who will take part in the meeting, and for their entertainment while in Pittsburgh. George H. Love, president, Union Collieries Co., was named chairman of the local committee, the other members being as follows: George S. Baton, president, Baton Coal Co.; J. M. Connor, general superintendent, Allegheny-Pittsburgh Coal Co.; H. N. Eavenson, president, Clover Splint Coal Co.; C. W. Gibbs, general manager, Harwick Coal & Coke Co.; R. B. Haverstick, treasurer, Harmon Creek Coal Corporation; Marshall J. H. Jones, president, Jones Collieries, Inc.; J. D. A. Morrow, president, Pittsburgh Coal Co.; A. B. Muse, vice-president, Bulger Block Coal Co.; H. B. Salkeld, president, Tasa Coal Co.; Thomas Watson, vice-president, Hillman Coal & Coke Co. Fred S. McConnell, vice-president, Enos Coal Mining Co., is chairman of the general committee.

Show Attracts Large Throng

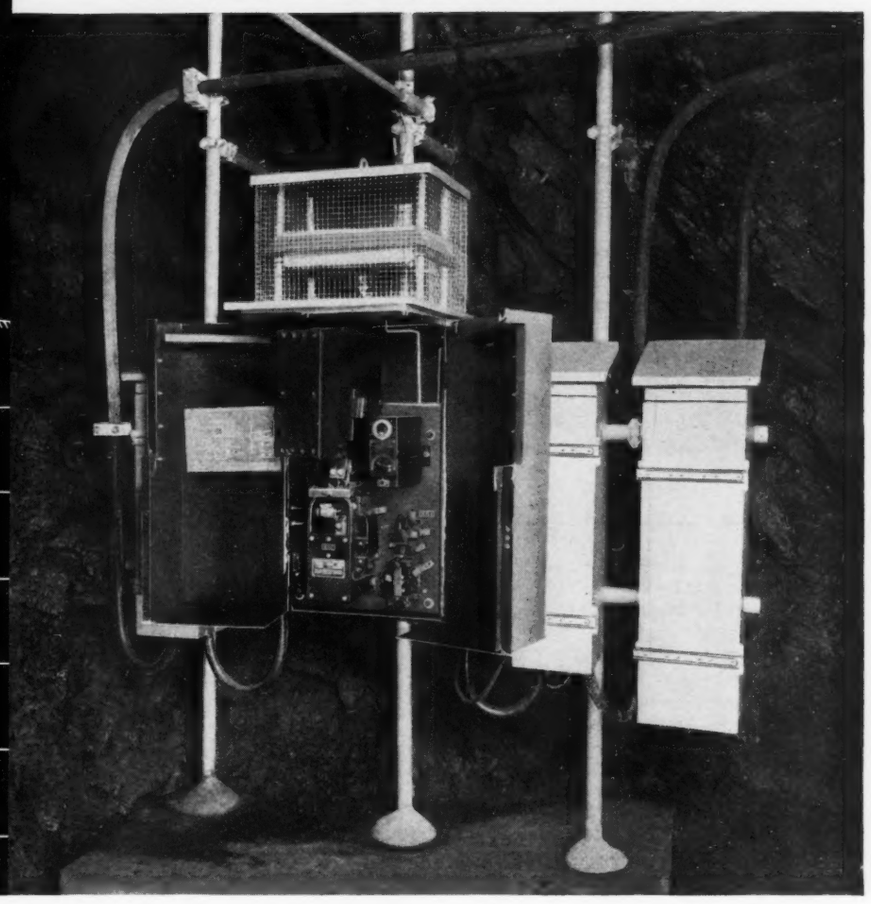
Nearly twenty thousand inspected exhibits covering practically every phase of coal mining and preparation at the third Southern Appalachian Industrial Exhibition, held Aug. 19-21 in Bluefield, W. Va. The large freight station of the Norfolk & Western Ry. was the scene of the exposition, which was sponsored by the Pocahontas Electrical and Mechanical Institute and participated in by the following coal operators' associations: Pocahontas Operators' Association, New River Coal Operators' Association, Big Sandy-Elkhorn Coal Operators' Association, Virginia Coal

MINE PLAN

Idealistic shaft development showing mining and haulage circuits controlled from individual Type KSC Circuit Breakers on each level.



Type KSC Automatic Reclosing Circuit Breaker protecting one level of operations at a large Anthracite colliery. The enclosing cabinet has been opened for inspection.



AUTOMATIC RECLOSING CIRCUIT BREAKERS IN A SECTIONALIZED ANTHRACITE SHAFT

List of I-T-E Circuit Breaker Company Bulletins dealing with the advantages of sectionalizing with Automatic Reclosing Circuit Breakers:

137 . . . Sectionalizing Circuit Breakers Reduce Costs at Oakwood Mine.

437 . . . Lowering Power Demand Charges at a Large Pennsylvania Mine.

537 . . . The Advantages of Sectionalizing Power by Use of Automatic Circuit Breakers.

I-T-E

Representatives in Principal Cities

Placing ONE Automatic Reclosing Circuit Breaker in control of EACH level of operations, is now accepted practice in the Anthracite Industry.

Growth in the number of sectionalized mines is the result entirely of economic advantages:

Low cost of the sectionalizing type of circuit breaker in comparison with the money value of the electrical and mechanical equipment protected on each level.

Increase in production by confining electrical disturbances to the levels in which they arise.

Reduced hazards of fire and explosion.

Reduced maintenance by preventing abusive operation of equipment under serious overload or on low voltage.

Decrease in total energy consumed and in power demand.

I-T-E CIRCUIT BREAKER CO., PHILADELPHIA, PA.

R. E. Howe

Operators' Association, Operators' Association of the Williamson Field, Kanawha Coal Operators' Association, Winding Gulf Operators' Association, Logan Coal Operators' Association, Harlan County Coal Operators' Association and Greenbrier Coal Operators' Association. B. B. Housman was director of the show.

Personal Notes

J. W. BAIN has been appointed foreman at the Osage No. 2 mine of the Pioneer Coal Mining Co., Osage, W. Va.

R. H. BARRY, formerly superintendent, Lafferty No. 6 mine, Hanna Coal Co., has taken a similar position at the Dun Glen No. 11 mine of the Hanna Company, Dun Glen, Ohio, vice E. J. Weimer, now with the Koppers Coal Co., Grant Town, W. Va.

EDGAR BLACKWELL has been made superintendent at the Summerlee mine of the New River Co., Fayette County, West Virginia.

E. BOWEN has been named foreman at the Shamrock mine of the Logan By-Products Coal Co., Logan, W. Va.

W. D. BRYSON, manager of operations, Colony Coal Co., Rock Springs, Wyo., resigned Aug. 28 to become general superintendent for the Utah Fuel Co., Salt Lake City, with headquarters at Castle Gate.

P. F. CARROLL, formerly with the Clearfield Bituminous Coal Corporation, Clymer, Pa., has been made chief electrician on the night shift at the Isabella mine of the Weirton Coal Co., Isabella, Pa.

J. T. CLARK, formerly superintendent at the Warden mine of the Pittsburgh Coal Co., Sutersville, Pa., has been made assistant production manager, succeeding Jerome C. White, resigned.

SAMUEL CORTES has been appointed superintendent of mines at Montour No. 4 mine of the Pittsburgh Coal Co., Lawrence, Pa., succeeding J. W. Woomer, resigned. Mr. Cortes formerly was foreman at Montour No. 4.

WALTER COCHRANE, foreman of the Royal mine of the Royal Coal Co., Rolapp, Utah, has become superintendent for the Standard Coal Co., Standardville, Utah. He succeeds A. E. Thompson, who had been superintendent for the company for about three years.

T. E. COSTNER, division superintendent of mines, Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., has been made general superintendent of mines, vice Roy Ratliff, promoted.

J. L. DOVE has been appointed foreman at the Glen Rogers No. 2 mine of the Raleigh-Wyoming Mining Co., Wyoming County, West Virginia.

HOWARD A. FEATHERS has been named foreman at the Byrne mine of the New Byrne Coal Co., Jordan, W. Va.

BROOKS FLEMING, JR., has been appointed director of employee service by the Consolidation Coal Co., with headquarters in Fairmont, W. Va., succeeding Fred Krafft, who has become associated with the Viscose Corporation at Philadelphia, Pa. Mr. Fleming has been connected with Consolidation for thirty years, serving in various capacities from clerk to assistant to the president.

H. L. GRIFFIN, formerly division engineer, northern West Virginia division, Koppers Coal Co., Grant Town, W. Va., has been made superintendent of the Lafferty No. 6 mine, Hanna Coal Co., Lafferty, Ohio.

W. T. HILLMAN has been appointed superintendent at the Glen Cambria mine of the Mountain Fuel Co., Flemington, W. Va.

R. E. HOWE has been elected president of Appalachian Coals, Inc., succeeding the resigned management committee consisting of John A. Howe (chairman), W. J. Cunningham and L. E. Woods, all three of whom continue as directors. A. L. BROWN, manager, marketing division, was elevated to the vice-presidency, succeeding Mr. Howe, and W. M. WILSHIRE was elected secretary-treasurer. Before joining A.C.I., Mr. Howe was secretary-treasurer of the Southern Appalachian Coal Operators' Association.

CARROLL B. HUNTRESS, recently associated with the New York office of the Consolidation Coal Co. as assistant to the vice-president, has become district manager in charge of the St. Louis office of the Republic Coal & Coke Co., of Chicago. Mr. Huntress succeeded Harry L. Gandy as executive secretary of the National Coal Association in 1930, becoming president of Appalachian Coals, Inc., in 1934. He resigned from the latter position in 1936 to campaign for Landon for President.

WALTER JAAP has been named general mine foreman at Montour No. 4 mine of the Pittsburgh Coal Co., Lawrence, Pa., succeeding Samuel Cortes, promoted.

J. O. JANEY has been appointed foreman at the Ameagle mine of the American Eagle Colliery Co., Ameagle, W. Va.

L. W. LILLY has been named foreman at the Golden Arrow mine of the Detroit Mining Co., Gordon, W. Va.

HARRY C. LIVINGSTON has been appointed assistant chief engineer, Union Pacific Coal Co., vice James L. Libby, deceased. Mr. Livingston had been draftsman and general assistant in the engineering department for the last ten years.

Delbert H. Pape

HUGO MACHIN, State coal-mine inspector of Colorado, formerly stationed at Colorado Springs, has been transferred to northern Colorado, succeeding James W. Graham, Sr., retired.

R. A. MCCLEVEY, secretary of the Northern Illinois Coal Trade Association since its organization, recently resigned to become vice-president and general manager of the Murphy Diesel Co., Ltd., Milwaukee, Wis.

L. D. MCNULTY has been named foreman at the Dayton mine of the Dayton Coal Corporation, Surosa, W. Va.

H. C. MARCHANT, secretary-treasurer of the Rocky Mountain Coal Mining Institute, has been placed in charge of the operations of the Colony Coal Co. at Rock Springs and Dines, Wyo., with the title of assistant to the president. He replaces W. D. Bryson, who recently became general superintendent for the Utah Fuel Co., Salt Lake City, Utah.

W. W. MCPHERSON has been made general foreman by the Pemberton Coal & Coke Co., Affinity, W. Va.

W. E. MCQUAIL has been appointed superintendent by the Turkey Gap Coal & Coke Co., Dott, W. Va.

DELBERT H. PAPE, formerly of Ogden, Utah, succeeds Harry L. Gandy as president of the Sheridan-Wyoming Coal Co. and the Hotchkiss Coal Co., both operating in Wyoming. Formerly vice-president and general manager of the Lion Coal Co., with mines in Utah and southern Wyoming, Mr. Pape was elected to succeed Mr. Gandy at a meeting of directors in New York. For a while after leaving the Lion company, Mr. Pape was connected with the National Coal Association in Washington, D. C., but in recent years he has been associated with retail subsidiaries of the Pittston Co., an affiliate of the Sheridan-Wyoming and Hotchkiss companies.

E. W. PRICE has been named foreman

Here is the Gulf engineer on the job—teamed up with the engineer in charge of the boiler room. The enclosed worm gear drive for the bowl mill, which pulverizes coal, must be protected with the proper lubricant. And the Gulf engineer is there to look over the equipment and recommend the right lubricant for the job.

This service is a *plus value* which users of Gulf lubricants receive. For the Gulf engineer has a thorough knowledge of all phases of plant and mine lubrication.

He has worked with all types of equipment, new and old. The Gulf line includes more than 400 oils and greases and he is prepared to recommend the proper lubricant and the best application method for each bearing, gear or moving part.

Many plant and mine operators have found that this service—extended to all users of Gulf lubricants without charge—has helped them make savings far greater than their total annual bill for lubricants. A Gulf engineer is always at your service.

GULF OIL CORPORATION ★ GULF REFINING COMPANY

GENERAL OFFICES: GULF BUILDING, PITTSBURGH, PA.

at the Leckie mine of the Leckie Smokeless Coal Co., Anjean, W. Va.

ROY RATLIFF, general superintendent of mines for the Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., has been appointed assistant to the vice-president and general manager.

GEORGE W. STONE has been made superintendent at the Byrne No. 1 mine of the New Byrne Coal Co., Jordan, W. Va.

D. E. TABOR has been appointed superintendent at the Bottom Creek mine of the Pocahontas Corporation, Vivian, W. Va.

I. E. VAUGHN has been named foreman at the Midland mine of the Greenbrier Fire Creek Coal Co., Charmco, W. Va.

G. R. WADDELL, of Wellsburg, has been appointed truck mine inspector by the State Department of Mines of West Virginia.

A. C. WATTS, assistant manager, Utah Fuel Co., Castle Gate, Utah, has severed his connection with that company.

J. L. WILLETTS, formerly with the Butler Consolidated Coal Co., Wildwood, Pa., has been made mine foreman in charge of the night shift at the Isabella mine of the Weirton Coal Co., Isabella, Pa.

WILLIAM WILLIAMS has been made foreman at the No. 9 mine of the United States Coal & Coke Co., Filbert, W. Va.

J. W. WOOMER, assistant engineer and later superintendent of mines, Pittsburgh Coal Co. for eight years, has joined the staff of the Hanna Coal Co., St. Clairsville, Ohio, as chief mining engineer. A graduate of Penn State, Mr. Woomer's early mining experience was with the Madeira-Hill organization, in Pennsylvania, and the Georges Creek Coal Mining Co., Lonaconing, Md.

JACK WRIGHT has been named foreman at the Whitesville mine of the Whitesville Mining Co., Whitesville, W. Va.

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Obituary

ABNER BELL ALDRIDGE, 57, president, Southeastern Fuel Co., and vice-president and general manager, Stith Coal Co., Birmingham, Ala., died in that city on Aug. 29 of complications resulting from an automobile accident last January. Settling in Birmingham in 1900, after several months study at a business college he obtained employment as a laborer on a night shift in the mines of the Sloss-Sheffield Steel & Iron Co., becoming within six years superintendent of the Brookside mine. In 1906 he joined P. J. Stith in forming the Stith Coal Co. Ten years later he was the moving spirit in consolidating large properties to form the Winona Coal Co., which later became the Southeastern Fuel Co. and of which he became president and a director. With the inauguration of N.R.A. he became administrator for coal in Alabama, Tennessee and Georgia, and in 1935 he was chosen president of the Alabama Mining Institute.

J. PAUL PEABODY, 55, president and general manager of the Rocky Mountain Fuel Co., Denver, Colo., died at his home in that city Sept. 2. He was a native of Albion, Mich., and had been connected with the company for more than thirty years, serving in various capacities.

Better Mine Illumination Would Promote Both Efficiency and Safety*

By CARL E. EGELER

Engineering Department, General Electric Co.
Nela Park, Cleveland, Ohio

ALTHOUGH underground mining illumination involves overcoming many problems not found in the usual industrial installation, it is possible to secure—at costs well in proportion to the production and safety benefits obtained—greatly improved lighting which, in addition to its operating cost features, will aid materially in conserving the vision and health of the workers. For particular operations, such as coal cleaning and picking and ore flotation, special lighting particularly adapted to the color and foot-candle requirements offers new opportunities for increasing the production per machine and worker. Doubling or tripling the expenditures for illumination—not at all unreasonable increases from the relatively low lighting costs which prevail—would permit the extension of lighting circuits to more work areas, allow the addition of reflectors to bare lamps which now are badly glaring, and so improve the quality as well as quantity that they would pay dividends in reduced accidents, higher production and better satisfied workers.

Largely because of the inherent limitations and difficulties which accompany extension of wired electrical power to work areas, illumination underground has not advanced as rapidly as in surface industries during the past quarter century. In other industries where illumination is an important part of the operation, expenditures for modern lighting may run well above 1 per cent of production cost, but for mining, where the aid of daylight never is available underground, figures of one-half and less of those percentages are too common. Proper lighting is an important factor in reducing accidents; with the total cost of accidents in mines (direct and indirect) between 20 and 25 per cent of the payroll, marked increases in lighting appear well warranted.

Why Not Floodlights?

At first thought it might be concluded that lighting at the face could best be accomplished by movable lamps or floodlights operated from the lighting or power circuits to deliver generous amounts of light—bearing in mind the very poor reflection from the surrounding surfaces (dry-coal reflection factors run little better than 5 per cent). This practice has been tried with some success in Europe, using 60- to 150-watt lamps in totally inclosing units of the waterproof bulkhead type. Its merits are the subject of further study from the standpoint of operating conditions in American mines. There are disadvantages which include physical hazard to the equipment resulting from the daily blasting, possibility of power cable being run over by the cars, heavy and cumbersome units if an explosion-proof construction is used, and the cost of providing suitable lighting circuits close to all of the more or less temporary working areas. Even with a more extended application of the general lighting from higher wattage sources the miner would not be safe without a portable lamp, and the battery-operated cap-lamp has been employed in this country as the primary source of illumination.

In the cap-lamp design emphasis is placed on directing a maximum amount of light in front of the miner for his immediate tasks. A typical distribution curve covering values with the battery discharged for about half of the 12-hour period shows that, with a center beam value of 45, at a distance of 3 ft. from the miner's head, the illumination will be approximately 5 foot-candles. This value is an outstanding contrast with those British and European coal mines where the usual lighting will average nearer 0.1 to 0.2 foot-candle. Such low values are largely the result of the use of hand lamps which emit light in all directions, or a minimum of 180 deg. horizontally, and in adjacent vertical zones.

Lighting the Shaft Bottom

Underground the shaft bottom is the area of greatest concentrated activity, since the haulage of the coal converges to this point, where the cars are loaded on the cage for transport to the surface. General illumination for switching cars in their movement onto the cage should be provided. Levels of from 10 to 20 foot-candles at the shaft, with gradually reduced values along the main entry past the near-by principal junctions and passageways, are suggested. Track junctions where switches are located should be well lighted to reduce the accident hazard at these points.

The better practice at the shaft bottom has been to use porcelain-enamel reflectors of the RLM dome type or angle type with 100- to 200-watt lamps. Usually the roof height of the main entry at this point has been increased and, in most cases, 300-watt lamps to provide illumination of the order of 15 to 20 foot-candles will be found definitely advantageous. In the interest of maximum reduction of the possibility of gas explosion due to breaking of the lamp, use of inclosed units is an obvious step toward greater safety. A heavy glass inclosure minimizes the possibility of breakage of the lamp bulb and, even should the protecting glass become broken, possibilities of the lamp bulb becoming fractured are much reduced. Use of approved explosion-proof units would provide maximum safety.

Coating the walls and roof white greatly increases the effectiveness and visual comfort of lighting. Concrete retaining walls can be painted, and the natural walls and ceiling whitewashed or rock-dusted. Direct current has been commonly employed (230-275 volts) but alternating current is being used to an increasing extent, especially in areas near the shaft.

Since the main haulageways have con-

* Abstract of an address, entitled "Illumination of Mines and Mining Operations," presented before the 31st annual convention of the Illuminating Engineering Society at White Sulphur Springs, W. Va., Sept. 27-30. The original paper covers both coal and metal operations, but treatment of the latter subject has been omitted from this abstract.

This Fatigue machine

has made it possible for Macwhyte to produce a tougher, stronger wire rope

● There are only a few of these machines in America. With this Haigh Robertson Fatigue Testing Machine, Macwhyte can measure quickly the resistance which the wire offers to repeated bending stresses. Constant experiments with this machine have helped Macwhyte to develop wire with a higher fatigue resistance. This operation is typical of Macwhyte's policy of producing only high quality wire. Constant research is one of the many reasons why Macwhyte PREformed Wire Rope gives such good service.

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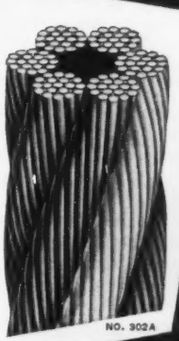
Monarch WHYTE STRAND PREformed Wire Rope is specially designed for jobs where ropes must stand up under severe bending. Macwhyte manufactures special constructions for shaft hoists, mining machines, loaders, haulage, shovels and dragline excavators. Macwhyte also makes specially designed non-preformed wire ropes.



MACWHYTE COMPANY, Kenosha, Wisconsin

Manufacturers of wire rope and braided wire rope slings
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tinual or frequent traffic, effective illumination for the full length would be advantageous from the standpoint of expediting the work and minimizing accidents. Past practice has been to place bare lamps, usually of 50-watt rating, at the junctions with side entries where switches are located, and in some cases for at least a few hundred feet commencing at the shaft bottom, in which case the lamps are placed from 50 to 100 ft. apart, a single 50-watt lamp being supported from two power wires. Where 550-volt locomotives are used, groups of five street-railway or multiple 115-volt lamps in series have been employed at the switch junctions.

With the black surroundings and bare lamps, not frosted, the direct glare is bad. Use of the inside-frosted lamps, now easily obtained, for mine-lighting service would improve this situation considerably. It would be desirable, however, if means of still further reducing the high brightness of the light source could be provided, and 100-watt lamps in shallow porcelain-enamel reflectors over the center of the tunnel will give very good results.

How Materials Rank in Visibility

Preliminary studies have been made of the relative visibility of bone coal, slate and so-called copper-stone under various illumination levels, using the Luckiesh-Moss visibility meter. The results of these laboratory data are shown in the curves of Fig. 1. Considering the illuminaton values provided by cap lamps, and comparing the visibility for shale at 5 foot-candles with that obtained with 2 foot-candles (the latter corresponding to the poorer present day and those values obtaining a few years ago from typical cap lamps), it will be seen that the increase in visibility is approximately 50 per cent. This significant difference emphasizes the new basis for appraising the function of light in industry—what it does for the seeing of the workers and not what foot-candles may be produced. In the field of mine lighting, it warrants wide application.

Information on the relation of mine production and illumination in the United States apparently is non-existent. Among the European data are the results of the German tests at the Wenceslaus mine, where the installation of a new lighting system using 150-watt lamps spaced about 15 ft. apart at the face increased production 25 per cent and decreased the waste raised to the surface almost 50 per cent; hand lamps only were previously employed. One company in the United States reported a decrease in waste content of over 50 per cent when old cap lamps were replaced with a newer model of higher light output. The need is great for more complete data on the experience of operating companies in this country.

Since individual loading machines represent a fairly high investment, continuous and efficient operation is an important phase of their use, and lighting units have been attached to the forward end of the machine in some cases. In general, due to their low mounting, small size and poor maintenance, they have not been very effective in furnishing desirable illumination in front of the machines and dependence still is placed on the workers' cap lamps for operation of the machine, collection of the coal to be loaded, and other allied activities. Increasing the mounting height from 5 to 6 ft. or more, higher lamp wattages of 150 to 250, reflectors and refracting cover glasses to spread the light over the work area, and provision for dustproof assemblies, and cleaning, should make the loading-machine-mounted units more effective work-lighting assets.

While some control can be exercised underground over the quality of coal sent to the surface, operating practice requires that the product be inspected and all undesirable material discarded in order that the quality of the product sold can be kept under close control. Discrimination gained by experience and relatively difficult visual processes are characteristic of this work, and special illumination is required. Both the color and the quantity of light are important factors. Since the extent, types, and colors of waste material will vary somewhat in different mines, the visual tasks are not always identical. In some

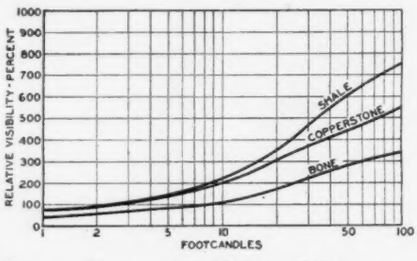

Fig. 1—Increase in visibility with increase in illumination for a group of coal samples.

locations correction of the light from high-wattage Mazda lamps to daylight quality has improved the efficiency of the picking operation. More recently it has been found that light of the quality emitted by the high-intensity mercury-vapor lamp has produced outstanding results, rendering better contrasts. Very high levels of the order of 200 to 500 foot-candles as obtained with the 400-watt lamps have worked out excellently.

Even where mechanical-cleaning processes are employed, foot-candle levels of from 15 to 40 have given great satisfaction to the operators using them. Too often it has been the practice to place 100- or 200-watt bare lamps, providing 2 or 3 foot-candles in what were felt were the more important locations, and not until the higher levels of illumination were employed was it appreciated that not only could the processes be better controlled but also the operators could do their work with less fatigue. The psychological advantages of the higher illumination levels were very noticeable.

Since the depreciation due to the collection of dust and dirt is unusually high it is important that definite cleaning schedules for the lighting units be established. Alternate washing and dusting of the lamps and reflector interiors on a regular schedule every three weeks would not be costly in relation to the added illumination obtained; the use of relatively high wattages in the better lighted plants will tend to reduce the number of units employed.

In general, 230- to 250-volt lighting circuits prevail underground. In comparison with the 115-volt class lamp, the general use of the higher-voltage type has inherent disadvantages, including approximately 20 per cent lower efficiency and decrease in strength, which, especially in the lower-wattage sizes, will affect the life performance in many locations. Moreover, the cost of the higher-voltage lamps is 70 to 90 per cent higher for most sizes. Thus for the same lamp expenditures, the use of 115-volt lighting circuits would give 2½ times or more the illumination obtained with the higher-voltage types. The difference is so great that theft of the lower-voltage lamps—a common argument against their use—should be much less costly than the loss in illumination, which, after all, is what the management is purchasing. An increasing use of alternating current underground makes it possible to employ 115 volts on the lighting circuits in a greatly increasing number of cases where the 230- or 250-volt d.c. circuits would normally be used.

Wide voltage fluctuations are characteristic at the lamp sockets in both coal and metal mines. Drops of 20 per cent below the average (which are not uncommon) reduce the light to less than half, and with even greater increases when the voltage fluctuates above the average, changes of as high as 4 to 1 in the illumination level result. The workers' eyes are continually trying to accommodate themselves to the changing light, with increased fatigue which would not be tolerated in most industrial plants. Use of separate lighting circuits would eliminate the cause of much of the trouble and the addition of the simple induction voltage regulators would greatly improve the effectiveness of the lighting by reducing the variations in the lighting levels which are so disturbing to the workers. The importance of adequate copper size for the lighting circuits cannot be emphasized too strongly. Voltage drops to the last lamp on the circuit should not exceed 5 per cent in the usual case, and when new circuits are installed, a drop not to exceed 2 per cent will allow for later addition of lamps, or increase in wattage, as the normal requirements expand.

Anthracite Engineers to Meet

Under the chairmanship of W. H. Lesser, of J. H. Pierce Management, arrangements have been completed for a joint engineers' meeting to be held in Scranton, Pa., during Anthracite Week, Oct. 9. The speakers will include Cadwallader Evans, Jr., vice-president, Hudson Coal Co.; F. W. Earnest, president, Anthracite Industries, Inc.; and Philip Sporn, vice-president and chief engineer, American Gas & Electric Co. The meeting will be sponsored by the local sections of the American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers, American Society of Mechanical Engineers, and the chambers of commerce in the anthracite field.

Anthracite Movie Shown

The field force, home-show organization and sales promotion group of Anthracite Industries, Inc., as well as its advertising representatives, took part in an all-day meeting on Sept. 1 at the Uptown Club, New York City. There was a preview of a new motion picture, "Green Lights Ahead," which depicts the past, present and future of the coal dealer, which will be shown in various cities throughout the country at

(*Turn to page* 96)

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luncheon and dinner meetings to be arranged by Anthracite Industries field men.

At the preliminary meeting the fall and winter anthracite advertising campaign, scheduled to start on Sept. 20, was discussed and advance proofs were exhibited. According to F. W. Earnest, Jr., president of the organization, the backbone of the campaign will again be newspaper space used throughout the area where anthracite is readily available as a domestic fuel. This area is gradually being broadened, now including Chicago.

A two weeks' course in the merchandising of anthracite and anthracite-burning equipment held at the Primos (Pa.) laboratory proved such a signal success that a regular series will be held, the next one starting on Oct. 4.

New Anthracite Firm Formed

The Reevesdale Coal Co. has filed incorporation papers in preparation to develop a 1,400-acre tract of anthracite land near Tamaqua, Pa., leased from the Philadelphia & Reading Coal & Iron Co. Officers of the new company are: president, Dr. Joseph T. McAloose; treasurer, John L. McAloose; secretary, William R. Douglas. Construction of a new breaker will start soon, according to Mr. Douglas, and production is expected to start late in December. About 600 men will be employed when production gets under way.

Mines Awarded Safety Honors

Six Colorado coal mines with the smallest number of accidents during the first six months of this year have been awarded shields to be erected at the mine entrances, according to an announcement by Thomas Allen, State coal-mine inspector. The mines so honored are: Ravenwood, Caliente Coal Co., Huerfano County; Kenneth, Vickers Coal Co., Rugby; Boncarbo, American Smelting & Refining Co., Boncarbo; Gordon, Gordon Coal Co., Huerfano County; Sopris No. 1, Deldosso Coal Co., Sopris; Cedar Canon, Giuliano & Carpine, Canon City.

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To aid users in securing more uniform results with alloy steels, Joseph T. Ryerson & Son, Inc., offers the "Ryerson Certified Steel Plan." Under this plan, Ryerson makes available from warehouse stock alloy steel which has been selected to meet specifications much closer than the standard S.A.E. ranges and which is accurately controlled in regard to grain size and other hardening characteristics. All bars except very small diameters are identified by letter symbols stamped on the ends, while bundles of small bars are tagged. All bars are metallurgically tested and the results of these tests, which cover both chemical analysis and heat-treatment response, are tabulated and transferred to data sheets identified by the same letter symbols. When a shipment is made, a data sheet for the bars shipped is placed in the hands of the user in sufficient time for study before actual working of the steel is started. A booklet on the plan is in preparation by the Ryerson organization.

Progressives Sign in Illinois After 6 Months Parley

After six months of negotiations, the Progressive Miners reached an agreement on Aug. 31 with the Coal Producers' Association of Illinois on a wages and hours contract. Providing for a 35-hour week and a $6 daily basic scale, the contract, which is for two years, in many features follows that signed on June 15 by the Illinois district union of the United Mine Workers.

A compromise was reached on controversial points that caused negotiations to be broken off a month previous, when Joe Ozanic, Progressive president, called his men from the mines and signed individual agreements with some mines. The union yielded in its former objection to a contract provision permitting coal digging on an extra shift. In return, the union officers and scale committee won a point when the operators eliminated a provision for a half hour of free hoisting after the regular seven-hour shift.

Madeira-Hill Files Plea

Madeira, Hill & Co., anthracite and bituminous mining and selling company, and six affiliates filed voluntary petitions in bankruptcy on Aug. 28 in the U. S. District Court at Philadelphia, Pa. Counsel for the company said the action resulted from competition, decreasing business and curtailment of bank credit. Two days later Harold D. Saylor, formerly first Assistant Attorney General of Pennsylvania, was appointed receiver. The group was reorganized in 1935 under Sec. 77b of the Bankruptcy Act. The affiliates affected are the Vulcan Smithing Coal Co., Philipsburg, Pa.; Thomas Colliery Co., Shenandoah, Pa.; Harleigh Brookwood Coal Co., Mahanoy Plane, Pa.; Mill Creek Coal Co., New Boston, Pa.; Hale Coal Co., Centre County, Pennsylvania, and Natalie Store Co., a supply concern with three establishments.

Norman Birpley, independent operator at Mt. Carmel, Pa., has leased the Lawrence mine, at Frackville, and, it is reported, will put back to work the 550 men made idle when the plant shut down.

Coming Meetings

- National Coal Association: annual meeting, Oct. 7 and 8, William Penn Hotel, Pittsburgh, Pa.
- Illinois Mineral Industries Conference: fifth annual meeting, Oct. 8 and 9, Urbana, Ill.
- Coal Producers' Association of Illinois: annual meeting, Oct. 12, Springfield, Ill.
- National Safety Council: 26th annual safety congress, Oct. 12-14, Kansas City, Mo.
- Northern Wyoming Coal Operators' Association: annual meeting, Oct. 15, Casper, Wyo.
- Coal Division, American Institute of Mining and Metallurgical Engineers: annual meeting, Oct. 27 and 28, William Penn Hotel, Pittsburgh, Pa.
- Illinois Mining Institute: annual meeting, Nov. 5, Hotel Abraham Lincoln, Springfield, Ill.
- Southern Appalachian Coal Operators' Association: annual meeting, Nov. 19, Knoxville, Tenn.

New Stripping in Indiana

A stripping operation covering more than 5,000 acres will be opened in Spencer County, Indiana, by the Mariah Hill Super Block Coal Co., Inc., which has been organized by O. C. Wulfman, Huntington, Ind. A five-track preparation plant will be erected by the company on the Southern Ry. near Dale, Ind. Mr. Wulfman is secretary and general manager of the company. Other officers, all of whom are connected with the Republic Coal & Coke Co., Chicago distributor, are: Lyle H. Dayhoff, president; H. D. Wright, vice-president and treasurer, and G. J. Leahy, vice-president.

Monarch to Expand

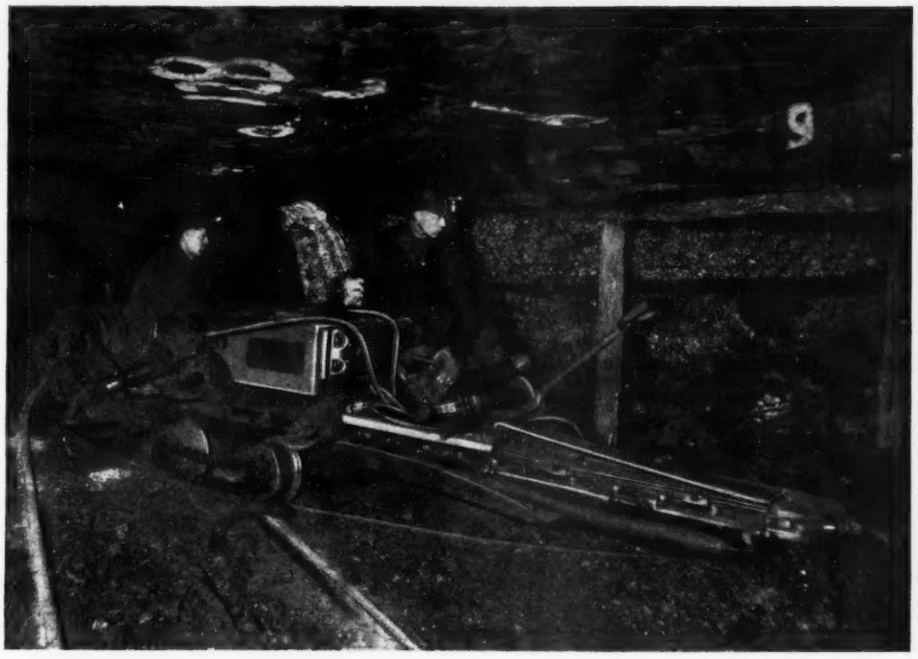
An expansion program that is to result eventually in the employment of 1,100 men during the coming winter has been started by the Monarch Anthracite Mining Co., Scranton, Pa., with orders for $30,000 worth of new equipment already placed, according to James H. Pierce, president of the company. Chance Coal Cleaner also has been commissioned to design a modern steel breaker to be erected if negotiations for a joint operating plan with the Scranton Coal Co. fall through. When the program is completed, said Mr. Pierce, the Monarch plant alone will produce 3,000 tons per day. Already its force has been increased from 523 to 798 employees.

Switchgear Exhibit

Featuring recently developed switchgear equipment, including oil-blast circuit breakers and various types of metalclad switchgear, the traveling exhibit of the General Electric Co. will visit a number of coal-mining centers in October and early November. October dates are: Chase Hotel, St. Louis, Mo., 8 and 11; Peabody Hotel, Memphis, Tenn., 14; Daniel Boone Hotel, Charleston, W. Va., 19 and 20; McLure Hotel, Wheeling, W. Va., 22; Fort Pitt Hotel, Pittsburgh, Pa., 25 and 26; and the Jaffa Mosque, Altoona, Pa., Oct. 29. On Nov. 1, the exhibit will set up at the Hotel Casey, Scranton, Pa.; Traylor Hotel, Allentown, Pa., Nov. 3; Berkshire Hotel, Reading, Pa., Nov. 5; and the Warwick Hotel, Philadelphia, Pa., Nov. 9, 10 and 11.

Penn Anthracite to Get Loan

A mortgage to secure a loan of $250,000 from the Reconstruction Finance Corporation to permit resumption of operations at the mines of the Penn Anthracite Collieries Co. in Lackawanna County, Pennsylvania, was authorized on Aug. 26 by Federal Judge Murray Hulbert. Application for



Lower Cost per ton with TIREX Cables

Coal miners in their effort to increase production don't have the time to take care of cables that carry power to your mining machines, locomotives or loaders, therefore, mining cables take more abuse than should be their lot in life.

In addition, falling coal, acid water and other handicaps make most cables wear out faster than they should. This is not true of TIREX Cables. The "Selenium Rubber Armor" of TIREX Cables is equal to the toughest place you can think of using it.

Years ago Simplex chemical engineers discovered that adding selenium to rubber greatly increased its toughness. The process was patented and consequently only Simplex-TIREX can be armored with the abrasion resistant "Selenium Rubber Armor."

Specify Simplex-TIREX when you want a cord or cable to stand up under constant abuse – then watch it lick the job.

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the loan was asked by Frederick E. Lyford, trustee for the New York, Ontario & Western Ry., which is being reorganized. An existing issue of $800,000 in bonds of the collieries company, secured by a mortgage on the mines and equipment, would be subordinate to the new loan. Counsel for the trustee said he had been assured that coal to be derived by the railroad company in the next year would amount to about a million tons, without which the carrier would suffer a serious loss in business.

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To Study Scientific Advances In Relation to Coal

The significance of current scientific and industrial developments to the Illinois coal industry will be the general theme of the fifth annual Mineral Industries Conference of Illinois, to be held Oct. 8 and 9 at the University of Illinois, Urbana. The meeting is being sponsored by the Geological Survey Division of the State Department of Registration and Education, the Engineering Experiment Station of the University of Illinois, and the State Mineral Industries Committee.

Under the chairmanship of M. F. Peltier, vice-president, Peabody Coal Co., and T. J. Thomas, president, Valier Coal Co., the program will include the following papers: "Research in the Mineral Industries," Clyde E. Williams, director, Battelle Memorial Institute; "Changes in the Constitution of Illinois Coals Through Preparation Processes, and the Importance of These Changes on Utilization," L. C. McCabe, Illinois Geological Survey; "Smoke Prevention Measures and Illinois Coal," Osborn Monnett, Commercial Testing & Engineering Co.; "Reclamation of Refuse at Illinois Coal Mines," C. M. Smith and D. R. Mitchell, University of Illinois; "Trends in Coal Selection for Small Stokers," K. C. Richmond, editor, *Coal-Heat.*

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Gibraltar Sale Confirmed

Sale of the Gibraltar Coal Mining Co., with three mines in Muhlenberg County, Kentucky, which had been in receivership since 1932, to Maurice K. Gordon, Madisonville attorney, for $126,000 was confirmed on Sept. 11 by Federal Judge Hamilton. The property had been offered at three public auctions, but no bids were received.

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Glamorgan Mine Sold

A newly formed company, the Peerless Coal Co., has acquired the coal property of Glamorgan Coals, Inc., in Wise County, Virginia, from O. M. Vicars and the J. J. Kelly estate, which bought it at receivership sale. Walter C. Shunk, of Bluefield, is president of the new company and J. C. Baldwin, formerly with the Pocahontas Fuel Co., will be in charge of the company's operations. Mr. Shunk, who for the last few years has been practicing as a consulting engineer, was formerly general superintendent of Stonega Coke & Coal Co. mines. The Glamorgan mines have been in operation since 1902, when they were opened by the Stonega Colliery Co.

Knotty Coal-Hydrogenation Problems Puzzle Chemists at Rochester

"HYDROGENATION of coal," admitted A. C. Fieldner, chief engineer, Experiment Stations Division, U. S. Bureau of Mines, at the meeting of Division of Gas and Fuel Chemistry, American Chemical Society, Rochester, N. Y., Sept. 7, will be of little practical value until the output of natural oil begins to wane. This decline, it has been estimated, will occur in ten to twenty years. It is well, he added, for the people of the United States to know before that time comes how to hydrogenate American coals most effectually and inexpensively.

Importance of type of coal, temperature, pressure, fineness of coal treated, material used to make the coal paste ready for hydrogenation (the "vehicle," as it is termed) and the catalyst used to aid the chemical reactions have been stressed, but latterly to these has been added agitation. Agitation, said L. L. Hirst, speaking for H. H. Storch, both physical chemists, U. S. Bureau of Mines, referring to experiments of Horton, King and Williams, should be placed before the catalyst and the catalyst before the vehicle as factors determining how much of the coal used can be converted into oil.

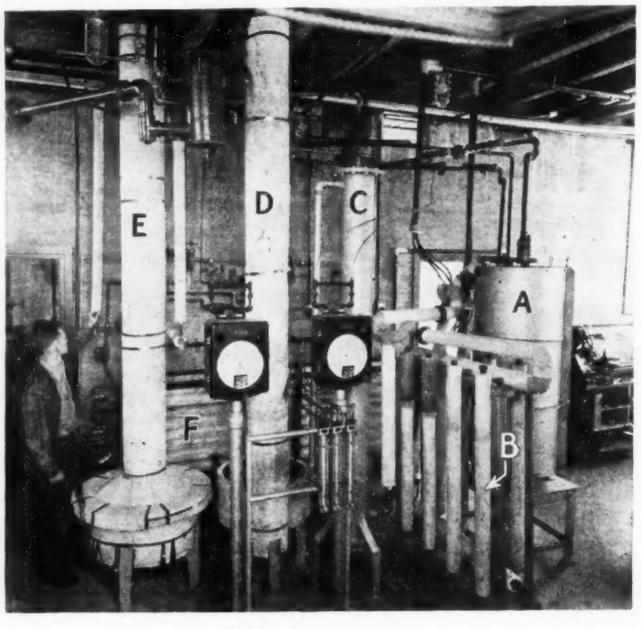
To make hydrogen for the conversion of coal to oil by hydrogenation, the U. S. Bureau of Mines has a water-gas generator consisting of two concentric tubes of 4½ in. and 7 in. exterior diameter and 5 ft. long made of high chrome-nickel steel (25 per cent chromium and 20 per cent nickel), asserted Dr. Hirst, speaking for Dr. Storch, P. L. Golden, I. I. Pinkel, R. L. Boyer, L. R. Schaeffer and R. H. Kallenberger, of the Bureau staff. The ring-like space between the pipes is filled with pure nickel wires ⅛ in. in diameter and ¼ in. long which act as a catalyzer to cause the steam and Pittsburgh natural gas to react on each other and form carbon monoxide and hydrogen.

Temperature is maintained between 1,000 and 1,100 deg. C. by a glow bar in the inner cylinder and a high-temperature-resistance heater around the outer tube. Equal volumes (about 100 cu.ft. per hour) of steam and natural gas are used in the generator. The gas contains about 90 per cent methane (CH_4), 8 per cent ethane (C_2H_6) and 1.5 per cent nitrogen. The water gas resulting has about 75 per cent hydrogen, 21 per cent carbon monoxide, 1 per cent carbon dioxide, 2 per cent nitrogen and 1 per cent methane. Pressure drop is 6 lb., which is overcome by use of a Roots-Connersville blower that provides 7 lb. pressure.

In addition, a shift catalyzer, continued Dr. Hirst, is provided to complete the reaction. That shown as *B* in Fig. 1 has been replaced by a 24-in. length of 6-in. steel containing at its center a 2-in. copper rod to which are attached eight copper plates which divide the chamber into eight equal catalyst spaces, so that the heat will be effectively conducted and the gas stream will not form large channels through the copper-cobalt catalyst with which those spaces are filled. (This catalyst consists of cobalt carbonate which has been rapidly heated with a small quantity of copper oxide to between 900 and 1,100 deg. C. or higher so that it sinters and forms a pumice-like granular mass.)

From the shift catalyzer the water gas goes to a water spray tower, *C*, where excess steam in the gas is condensed, and then to an 8-in. x 12-ft. tower scrubber, *D*, to remove carbon dioxide. The latter is packed with ½-in. carbon Raschig rings, and a spray of 10 per cent tetramine scrubs out the carbon dioxide. The spent tetramine is renewed in the 8-in. regenera-

Fig. 1—Where hydrogen is removed from water arnd purified for use in the hydrogenation converter.



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Blakstix Type Black Powder has an action all its own . . . a pushing action!

Blakstix action makes more lump that stays lump!

Blakstix Cartridge is more convenient!

—easier to use. Each cartridge may be broken into quarters, halves or three-quarters simply by pressure of the hands. No cutting; no unwrapping—a mighty handy feature.

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End wads are securely crimped. A tough, yet elastic waterproof wax (not paraffin) seals the ends effectively. Each shell is individually dipped to insure a complete, uniform coating.

Atlas Blakstix Type Black Powder should be used wherever Black Blasting Powder Products may be safely employed. It produces lump that is easier to handle—easier to clean—coal that brings better prices. A demonstration, arranged by the Atlas representative, in your own mine—will point the way to profit!

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ATLAS

EXPLOSIVES

CHEMICALS ATLAS EXPLOSIVES

tor *E*, consisting of a 12 x 30-in. boiler attached to a 12-in. x 11-ft. distillation column also packed with ½-in. carbon Raschig rings. To save heat, the regenerated tetramine which is hot is taken to a heat exchanger, *F*, where it gives off some of its heat to the spent tetramine from the scrubber, lightening the heating load on the regenerator, to which it is pumped through a spray head in the center of distillation column *E*. The hydrogen is stored in 25 high-pressure cylinders, each holding 200 cu.ft. of the gas as measured at atmospheric temperature. This hydrogen plant is run only when needed to replenish the storage cylinders. The gas produced contains 96 per cent hydrogen, 0.5 per cent carbon monoxide, 0.2 per cent carbon dioxide, 1.2 per cent methane, 0.2 per cent oxygen and 1.9 per cent nitrogen.

Where Coal is Hydrogenated

Coal for conversion to oil in the coal hydrogenation plant is delivered in the form of a paste of fine coal and oil by a small rotary pump at 30-lb.-per-square-inch pressure to a high-pressure chemical proportionating pump, which in turn delivers it to the bottom of the converter, continued Dr. Hirst. The oil used in the Bureau's experiments for the purpose was derived from the hydrogenation operation. The mixture is hydrogenated in a converter consisting of a steel tube of 5-in. outer and 3-in. inner diameter and 8 ft. long. The steel contains 18 per cent of chromium and 8 per cent of nickel. Hydrogen is pumped into the converter through its top, then passes through a heat exchanger consisting of about 50 ft. of ⅛-in.-bore aluminum tubing in flat pancake coils, and then passes to the bottom of the converter, where it bubbles out into the coal-oil paste through six jets, giving the much desired agitation. On reaching the oil surface, the hydrogen and volatile light oil which it contains pass over the outside of the heat-exchanger coils and surrender much of their heat.

A cylindrical electrical resistance furnace surrounds the converter. Though the latter will withstand a pressure of 4,500 lb. per square inch, the coal is hydrogenated at 3,000 lb. and effort is made to keep the pressure constant at that figure. Temperatures of the liquid in the converter have run from 410 to 433 deg. C., with outside-wall temperatures about 10 deg. C. higher. The heavy oil, when discharged through a valve, added Dr. Hirst, contains so much ash that the operation of the valve is uncertain, for the pressures fall from 3,000 lb. per square inch to atmospheric pressure. It has been found best to discharge the oil through a coil of small diameter which throttles the passage. It is easy to control the exit of the light oil, as it is free of ash. Should the heat-exchanger coils leak and bypass the paste in the converter, the coal will coke and not liquefy.

Light oil and hydrogen pass to two traps in sequence. In the first trap, light oil is condensed, and in the second, hydrogen sulphide, water vapor and carbon dioxide are removed from the hydrogen by a layer of caustic soda. From this second trap the hydrogen is drawn by a recirculation pump and forced back into the converter.

In discussion Dr. Hirst stated that the catalysts used were molybdic acid ($MoO_3 \cdot 2H_2O$) and monosulphide of tin (stannous sulphide) (SnS), each being used at present in the proportion of 0.25 per cent of the total weight of paste. The Bureau had made no test as to poisoning of this catalyst in use, as it was used once only and not recovered; 0.5 per cent of catalyst was employed, based on the quantity of coal to be liquefied. No studies had been made as to the effect of varying the quantity. Capacity of this pilot plant is 100 lb. of coal in 24 hours. Operation is continuous. Up to the present, only Bruceton (Pa.) high-volatile coal has been tested. Later, a wide range of coals will be hydrogenated.

Only by continuous plant operation can one ascertain what will happen when coal is to be hydrogenated commercially, observed R. E. Gilmore, on behalf of T. E. Warren, Fuel Research Laboratories, Canadian Bureau of Mines. In continuous hydrogenation, the composition of the reacting material does not change (the material being constantly renewed), catalyst, ash and other solids are in high concentration and non-volatile matter receives lengthy treatment, whereas in batch operation the composition of the reacting material changes continuously through the run, catalyst and ash are in low concentration, and all the material is treated for the same length of time. Results of batch and continuous operation naturally vary greatly, and not always in the same direction, as is set forth in Table I.

Table I—Oil Yield From Three Coals With Batch and Continuous Operation

Coal Used	Batch Operation	Continuous Operation
Nova Scotia high-volatile	64.0	77.6
British Columbia medium-volatile	70.4	66.2
British Columbia high-volatile	45.6	67.6

Coals react to hydrogen roughly in inverse proportion to their carbon content, asserted Dr. Hirst, delivering an address prepared by Dr. Storch. In laboratory tests with small bombs at 450 deg. C. and about 100 atmospheres initial (cold) pressure hydrogen kept for two hours at reaction temperature, the yield of oils boiling below 360 deg. C. decreases approximately in proportion to the carbon content of the coal, but, in experimental continuous plants, this relationship is more complex. For many reasons, a coal which gives a fair yield of oil in a bomb test may fail wholly to indicate the results obtainable from a continuous hydrogenation plant.

If the best range for the primary hydrogenation is too narrow, the continuous plant may fail to give satisfactory results because the temperature control is not as precise as in bomb tests. Other causes are the presence of fusain and resin in the coal and the specific disposition of the coal to resist the action of the vehicle in peptizing; that is, in dividing its particles colloidally, for this determines the ease with which the mixture is pumped. Relation of oil yield to the type of coal, whether anthraxylon or attritus, has not been completely investigated, said Dr. Hirst, but it is generally recognized that the fusain in the coal will not readily hydrogenate. The oil yield from the Lancashire Arley seam coking coal (of 84 per cent carbon content) is about 70 per cent greater than that from the clarain and durain (of 81 to 82 per cent carbon) from the non-coking coal of Staffordshire.

Table II—Small Autoclave Tests on Influence of Vehicle,* Catalyst† and Agitation

Experiment Number	Vehicle	Catalyst	Agitation	Oil Yield Per Cent on Coal
1	No.	No.	No.	23
2	No.	Yes.	No.	49
3	Yes.	No.	No.	36
4	Yes.	Yes.	No.	46
5	Yes.	No.	Yes.	54.4
6	No.	Yes.	Yes.	64
7	Yes.	Yes.	Yes.	7
	Identical Except for Agitation			Increased Yield Per Cent
5–3	.....	.....	.....	18.4
6–2	.....	.....	.....	15.4
7–4	.....	.....	.....	24.3
	Identical Except for Catalyst			
3–1	.....	.....	.....	13
4–3	.....	.....	.....	10
7–5	.....	.....	.....	15.9
	Identical Except for Vehicle			
3–1	.....	.....	.....	13
4–2	.....	.....	.....	—3
7–6	.....	.....	.....	5.9

* Coal tar distillate † 0.1 per cent (on weight of coal) of tin oxide (SnO) or germanium oxide (GeO)

Products of the hydrogenation of bituminous coals, continued Dr. Hirst, are largely aromatic (ring-structured), whereas about 12 per cent of paraffin hydrocarbons (of chain structure) are reported in brown-coal hydrogenation. Paraffin wax is manufactured by extracting part of a brown coal with benzol under high pressure and hydrogenating the extract.

For every coal there is a temperature best suited for its hydrogenation. Above this, polymers are precipitated. The best temperatures for most bituminous and brown coals, according to Pott and Broche, are between 390 deg. and 410 deg. C. when equal parts of coal and of the composite solvent, tetralin, phenol and naphthalene, in the proportions 2:1:2 are used. The product of this extraction resembles primary coal tar.

Completely saturated hydrocarbons, according to Fisher and Eisner, usually are poor vehicles, observed Dr. Hirst. Tetralin is an excellent hydrogenation medium, and mixtures of tetralin with naphthalene, toluidine, cresol and quinoline are equally satisfactory or superior to tetralin. Methyl naphthalene is a much better vehicle than naphthalene. In general, phenols and amines increase the effectiveness of all aromatic and hydroaromatic vehicles.

Agitation, according to Horton, King and Williams experiments, is more effective than the use of a catalyst or vehicle, as can be seen from Table II, but this applies only to early stages of hydrogenation; that is, liquefaction to produce "heavy oil." Probably the three variables are dependent on each other.

Recent patents, said Dr. Hirst, empha-

★ ★

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Goodman Manufacturing Co.: Type G-20-B-77 shaker conveyor; 25-hp. motor, 440 volts, a.c.; Approval 325-A; Aug. 23.

Thomas A. Edison, Inc.: Type M2 hand lamp; Approval 1016; Aug. 30.

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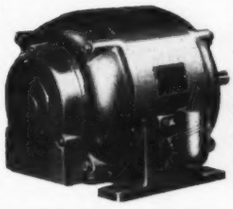

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size the desirability of adding to catalysts volatile chlorides or compounds that at process temperatures will decompose and yield such chlorides. Promoted heavy metal sulphides and finely divided metals are also patented catalysts, so are alkali and alkali-earth metals and their compounds when used together with finely divided iron or other metals.

Amphoteric sulphides (those on the border line between acids and alkalies)—namely, molybdenum disulphide (MoS_2), tungsten disulphide (WS_2) and stannous disulphide (SnS)—are the most active of the metal-sulphide catalysts! the last is most active when the material to be hydrogenated is still liquid. Molybdenum and tungsten disulphides give their best action when the tars or liquid primary coal hydrogenation products have become vapors. Sulphides usually are more active than oxides and a minimum partial pressure of about one atmosphere of hydrogen sulphide is desirable to prevent the metal sulphides from being converted to oxides or to metals.

Boomer and Saddington, declared Dr. Hirst, had found it possible in a small bomb test to obtain good yields of oil using tetralin and 150 atmospheres pressure of methane. In the vapor form, or phase, hydrogenation of oils obtained from coal, high-pressure hydrogen probably is necessary; otherwise, the hydrogenation actions may reverse. But temperatures as high as 460 deg. C. for vapor-phase hydrogenation probably are not necessary. Recent patents indicate that much lower temperatures may suffice when sufficiently active catalysts are available.

Fairly good results can be obtained without a catalyst, asserted Dr. Gilmore, presenting the discussion of Dr. Warren. With 5 per cent stannous sulphide (SnS), probably not the most active of tin compounds, and used in large quantity to compensate in part for low activity, 77.6 per cent of oil was obtained (based on ash and moisture-free coal) at a temperature of 443 deg. C. and a pressure of 2,940 lb. per square inch. Without any catalyst, the yield was 69.7 per cent at a temperature 1 deg. C. lower and at the same pressure. Both coals were high-volatile coals from Nova Scotia.

In preparing coal paste for hydrogenation by the Bergius process, the coal is mixed with a vehicle. Studies have been made by the U. S. Bureau of Mines, stated C. H. Fisher for himself and Abner Eisner, to discover a better vehicle than the oil derived from the hydrogenation process, even though use of the products of the plant itself has economic advantages. By heating the coal, with some suitable vehicle, under an initial pressure of 1,000 lb. per square inch, increased to 2,500 lb. under heat, it can be hydrogenated, liquefied and divested of some of its oxygen, nitrogen and sulphur.

One of the best of these vehicles is tetrahydronaphthalene, otherwise known as tetralin ($C_{10}H_{12}$). Coal was treated in a stainless-steel converter of the same percentage composition as that used in the hydrogenation converter, previously described, but the equipment used has a capacity of only 1,200 c.c. and is designated as a bomb. It is arranged for rotation on its horizontal axis for more perfect admixture of coal with vehicle. All tests were made with Bruceton coal with moisture, 1.6 per cent; volatile matter, 35.7; fixed carbon, 56.4, and ash, 6.3.

Table III—Liquefaction Yields From Use of Tetralin

Times, hours	Conversion of Pure Coal: Based on Residue	Conversion of Pure Coal: Based on Ash Content
Temperature 385 deg. C.		
3	83.6	80.7
6	91.0	89.8
9	92.2	91.3
12	94.4	93.2
Temperature 400 deg. C.		
3	91.5	89.0
6	93.6	92.3
9	95.4	93.7
12	95.4	94.8
12	99.2*	98.6*

* Based on the starting material (100 grams of pitch obtained by hydrogenating Bruceton coal for three hours at 400 deg. C.).

To obtain comparable results, said Dr. Fisher, coal was hydrogenated at both 385 and 400 deg. C. In each case a gram of monosulphide of tin (SnS) and 100 grams of coal, ground to pass a 200-mesh sieve, were mixed and placed in the bomb and 100 grams of tetralin added. After the bomb had been flushed, first with nitrogen and then with hydrogen, the latter gas was introduced until a pressure of 1,000 lb. per square inch was obtained. After a half to a full hour the pressure had fallen, for some of the hydrogen dissolved in the coal-oil paste, so the pressure was restored to 1,000 lb. per square inch by adding more hydrogen. Then the temperature was raised at the rate of 2 deg. C. per minute until one of the two temperatures mentioned was attained. It was held at that level for three hours.

If the test was to be stopped at that point, the converter was allowed to cool to room temperature, and the gases were passed to a gas holder through wash bottles containing about 15-per-cent solutions of sulphuric acid and sodium hydroxide. The converter was opened and its contents analyzed, as also the samples from the gas holder and solutions from the wash bottles. In the experiments of six, nine or twelve hours' duration, the converter was not opened at the end of the three-hour period but was bled of its gas, flushed with hydrogen and recharged with the latter gas to a pressure of 1,000 lb. per square inch. This action was repeated every three hours for the nine- and twelve-hour tests (see Table III).

Oxygen removal, stated Dr. Fisher, during the first three hours is very rapid, but thereafter it is much slower. Hence, it is probable that the coal substance either embodies at least two types of linkages or that the original oxygen linkage in the coal yields upon destructive hydrogenation a second type which is more difficult to hydrogenate.

"Nitrogen removal was very slow," he added, "and approximately constant." Complete removal of nitrogen by hydrogenation at 400 deg. C. or lower would be extremely difficult. Graphs for organic sulphur content are of the same qualitative shape as those for oxygen, but the differences between the first and later three-hour intervals are smaller.

Available hydrogen is defined as the hydrogen remaining after enough of that gas is removed to satisfy the oxygen and form water and to satisfy the nitrogen and form ammonia. It was found that the available hydrogen increased rapidly in the first

Fig. 2—Oxygen, hydrogen, nitrogen and organic sulphur contents of hydrogenation pitches.

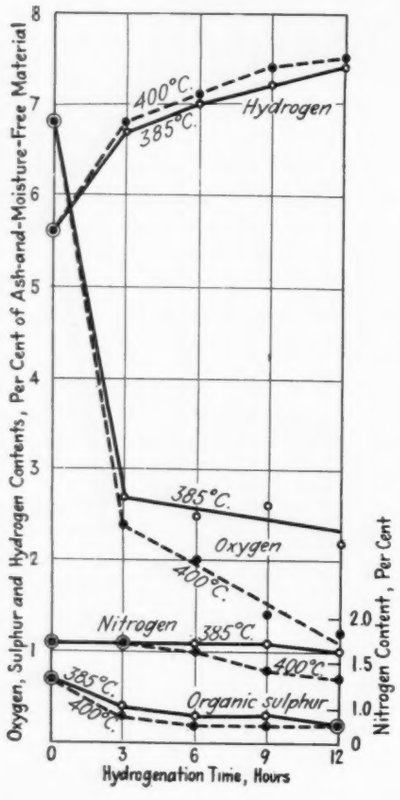
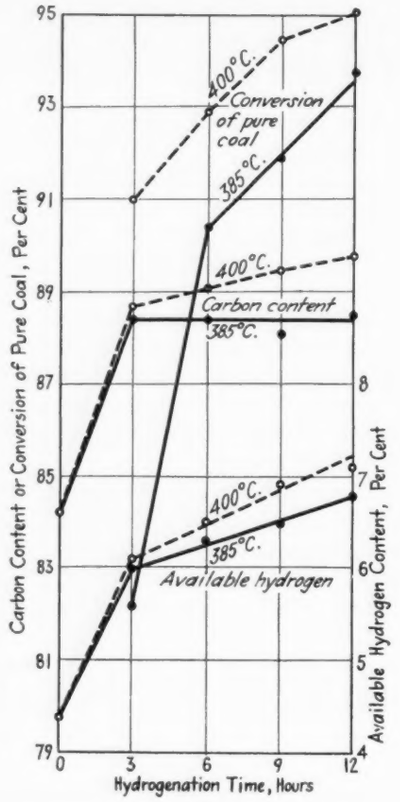


Fig. 3—Available hydrogen and carbon contents of pitches and percentage of coal converted.



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three hours and not so rapidly in the hours that followed.

Carbon content, observed Dr. Fisher, increased rapidly for the first three hours at both temperatures, but after that it did not increase at all at 385 deg. C., though, at a temperature of 400 deg. C., an increase of some proportion, much less than in the first three hours, occurred in the last nine.

Most of the liquefaction at both reduction temperatures occurred in the first three hours of hydrogenation; especially was this true of the coal treated at 400 deg. C., for the first three-hour period converted 91 per cent of the pure coal substance, whereas the second three-hour period was more important in the tests at 385 deg., in which the conversion increased from 82.2 to 90.4 per cent of the pure coal.

Liquefaction of coal was greater at 400 than at 385 C., as might be expected, asserted Dr. Fisher, but the beneficial effect of the higher temperature diminished with the duration of the experiment. The peculiar composition of the residue resistant to liquefaction and the fact that the last three-hour period at 400 deg. effected only a negligible increase in yield indicate that yield of liquefaction products is limited by the presence of a material quite different from the rest of the coal substance. As coal from the Pittsburgh bed usually has 2 to 3 per cent of fusain, it appears that some other constituent than fusain in this coal is unusually resistant to hydrogenation, a conclusion verified by microscopic examination, which revealed spore remains as well as fusain in the residue.

Yields Vary With Coals

The theory that two different types of oxygen linkage exist in coal, one of which is quickly hydrogenated and the other much more slowly, agreed Dr. Gilmore, again speaking for Dr. Warren, may have a bearing on the amenability of different coals to the process. That is, different coals may have differing proportions of easily hydrogenated linkage. A high-volatile bituminous coal from Nova Scotia gave 77.6 per cent of oil and a similar coal from British Columbia only 67.6 per cent.

Just what effect the chemical nature of a solvent has on the quantity of material it can extract from coal, a hitherto neglected study, was discussed by R. S. Asbury, Coal Research Laboratory, Carnegie Institute of Technology. Fifty-three solvents were used, but the results obtained with six were rejected, as it was evident that the solvents had reacted with the coal or had decomposed excessively or that the mixture polymerized to a hard mass, insoluble in all solvents tried.

Internal pressures at 200 deg. C. were calculated, and it was found that there is a relationship between these pressures and quantity extracted when the latter is based on the difference between weights of coal and residue. All extracts contained some ash, according to Dr. Asbury, though many have reported that theirs were ash-free. In many cases the solvents lost elements in the process. All experiments were made on Pittsburgh bed coal from Edenborn, Pa.; the capacities of the bombs in which the mixtures were revolved were in each case 300 c.c. and the temperature of the bomb at the middle was 200 deg. C.; time was made 120 hours, so as to obtain maximum extraction. Less time, it was ascertained in every case, would have sufficed.

Coordination Machinery Under Headway To Set Minimum Prices Soon

WASHINGTON, D. C., Sept. 18—Bending every effort to establish minimum prices for coal early in October, before the peak of buying is reached, the National Bituminous Coal Commission issued an order on Sept. 15 to aid in stabilizing the market pending the fixing of prices. The new order prohibits code members from entering into contracts or accepting orders for delivery of coal for longer than 30 days. This move was made, the Commission explained, to give full force and effect to minimum prices when established. A ban also is placed on granting a discount or price allowance on the undelivered portion of any contract already in existence, after the fixing of minimum prices, unless the contract price is not less than the code price in effect at time of delivery. Contracts entered into prior to June 16, 1933, as set forth in the Guffey-Vinson Act, are not affected by the latest order, if they are authenticated by the Commission in conformity with regulations to be prescribed later. A total of 4,335 operators, who produced 413,877,916 tons of coal in 1936, or 97.29 per cent of the output, have accepted the code to date.

With more than 200 representatives of the industry present, the Commission began the work of coordinating minimum prices for coal in Minimum Price Areas Nos. 1 and 2 on Wednesday, Sept. 8, at the Carlton Hotel. District producers' boards Nos. 1 to 12 (comprising roughly all producing areas east of the Mississippi and accounting for approximately 90 per cent of the nation's output) were represented. The meeting was divided into four sections and preliminary price-coordination conferences were started between district boards whose coals compete in common consuming markets.

Proposed minimum prices were filed with the Commission by these boards on Sept. 2, and the Commission has set Sept. 27 as the date for a hearing on the coordination of prices. In order to facilitate the district boards' work of determining minimum prices, the Commission has established the tentative weighted average cost of production in Minimum Price Area No. 1 at $2.22 per net ton and for Price Area No. 2 at $1.88 per ton.

Alabama to Submit Prices

The Commission issued on Sept. 10 an order directing producers' boards in Alabama and all States west of the Mississippi to propose minimum prices by Sept. 24. To facilitate determination of these prices by the boards the following tentative average production costs have been set in the seven areas affected: Minimum Price Area No. 3 (Southeastern), $2.57; No. 4 (Arkansas-Oklahoma), $3.87; No. 5 (Southwestern), $1.94; No. 6 (northern and southern Colorado and New Mexico), $2.63; No. 7 (Wyoming and Utah), $2.37; No. 9 (Montana), $2.04; No. 10 (Washington and Alaska), $3.35.

Boards within Minimum Price Areas Nos. 1 and 2 which deem it necessary to coordinate their minimum prices with those proposed by any of the districts in Areas Nos. 3-10 are authorized to attend a coordination meeting in Washington on Sept. 28 under direction of the Commission. Coordination is to be completed by Oct. 2, the coordinated prices to be open for public inspection at the office of the secretary of the Commission on and after Oct. 4. On Oct. 7 the Commission will receive evidence to enable it to establish and make effective minimum prices.

A public hearing was announced by the Commission on Sept. 10 to be held in Washington on Sept. 27, when evidence will be received to enable the Commission to establish initial classifications of coal produced by all members of the Bituminous Coal Code. District boards were directed to inform all code members of proposed classifications for the output of all mines not later than Sept. 16. Any code member dissatisfied with classifications for his coals may protest to his district board, which is empowered by the Commission to hear such protests. Code members also are allowed to propose reclassifications for their coals at any time, but where a protest has been made to a district board and a decision rendered by the Commission, no further protest or application for reclassification can be made within 90 days from the date of the Commission's order. Proposed initial classifications are to be filed with the Commission by Sept. 23, and all protests are supposed to be heard and disposed of, as far as practicable, before that date.

Commission Wants Facts

A hearing on coordination of rules and regulations incidental to the sale and distribution of coal, adjourned from Aug. 26 to Sept. 9, was continued by the Commission until Sept. 20, on which date evidence also will be received on the establishment of distributors' discounts, which was discussed at a hearing on Aug. 17. The August hearings brought out a large volume of testimony. though Chairman Hosford expressed impatience at the "absence of facts." He warned the witnesses that, in the absence of factual data, the Commission could prescribe a maximum allowance of 5 per cent of the minimum code price to cover discounts, if it saw fit to do so.

The question of whether North Dakota lignite should be exempt from the provisions of the code was discussed at a hearing on Sept. 13 before Examiner Carman A. Newcomb in the Prince Hotel, Bismarck, N. D. Stanley B. Houck, counsel for the State's lignite producers, presented testimony by a group of operator-sales executives, to show that no coal except that conforming to the specifications of lignite was to be found in North Dakota (not less than 30 per cent moisture or more than 7,600 B.t.u.). Those who testified to this effect were Wesley E. Keller, vice-president, Truax-Traer Coal Co.; F. A. Barthelme, Republic Coal Co., and O. T. Solberg, Knife River Coal Mining Co.

Mr. Keller asserted that one sample of his company's product air-dried once showed slightly more than 7,600 B.t.u. and moisture in excess of 30 per cent, but that no subsequent samples have shown a B.t.u. content even approaching 7,600. L. C. Har-

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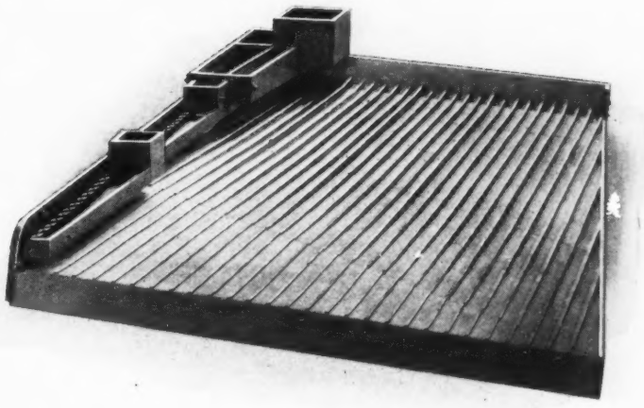

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rington, dean of the School of Mines, University of North Dakota, described the results of an F.E.R.A. project in 1934 in the course of which 600 samples of lignite from every section of the State were tested. He said that the moisture content varied from 31 to 40 per cent, with an average of 36.37, and that the B.t.u. was from 6,000 to 7,200. This, he contended, gives it about one-half the heat value of good bituminous coal.

An act of this sort or the Commission administering it, declared D. H. Pape, president, Sheridan-Wyoming Coal Co., Monarch, Wyo., should fix its own quality standards and not rely upon some form of quality fixation which preceded passage of the act. "These should be so fixed," he said, "that lignite should submit to the same tests as sub-bituminous and bituminous coals."

Three days ending Sept. 11 devoted to a hearing at Springfield before Trial Examiner Charles O. Fowler, of the Commission, developed almost complete unanimity among producers, distributors and retailers in the view that all coal mined in Illinois should be subject to the bituminous coal code as affecting interstate commerce. Only two of those who appeared indicated that they believed any mines in Illinois should not be so restricted. These were W. Edgar Sampson, a Springfield attorney, who said he represented the Greenview Mining Co., of Menard County, and T. W. Samuels, of Decatur, who appeared as a citizen and a taxpayer.

Spurns All Statistics

Mr. Sampson challenged all of the statistics submitted by witnesses describing the movement of interstate and intrastate coal on the ground that they were hearsay. His objections were against official reports as well as the summations of figures prepared by railroad, trade and other semi-public bodies and submitted and analyzed by the witnesses. Again and again he sought to prove that none of the interstate coal described by the various witnesses came into competition with the coal he represented, which, he said, was sold only within a radius of 50 miles of the mine. Several witnesses, however, testified that tonnage from west Kentucky and Indiana came into competition with the Menard County product within a few miles of the county border.

Charles W. Shinnamon, executive secretary, District 2 Producers' Board (northern West Virginia), took the position that the minimum prices to be established under the Guffey-Vinson act not only should not result in increased prices to household consumers but perhaps in a decrease in the share that this large class of users has to bear in the cost of bituminous coal. "It should result in a fairer deal for all. Under the present price working," declared Mr. Shinnamon, "the large railroad, industrial and utility users come into the market around April 1 each year, and, after shopping around, playing one producer against another and one field against the other, they generally obtain their coal at or below the cost of production. When the small buyer comes into the market, in the winter, when prices are firm, he is asked a price that will show a profit on his 20 per cent of the bituminous business sufficient to wipe out the losses on the 80 per cent placed by the big users."

Though not heard on the witness stand, a number of small truck-mine operators were at the hearing and conferred with legal and other attaches of the Commission. Many of these men expresed a desire to join the code, but confessed to confusion as to how to go about it and how to keep books and records in accord with the Commission's requirements. All expressed belief that they would retain their competitive advantages with the larger mines and with coal from other States, though they should be included in the minimum prices set.

George W. Reed, vice-president, Peabody Coal Co., and a member of District 10 board, charged, however, that many of the operators of these mines were producing coal very cheaply because they paid no attention to the safety and other requirements of the State mining laws. He said frequent complaint to the State Department of Mines and Minerals failed to bring about improvement in enforcement of these statutes. He also testified that only the collective bargaining provisions of N.R.A. had saved the Illinois industry from ruin in 1933, when Illinois mines paying the union scale were menaced by the competition of Southern operations where workers were getting $1.50 a day for 13 hours' work. He predicted that a similar state of affairs would come about for the regulated mines doing an interstate business if local mines in other States as well as in Illinois were free of the requirements of the bituminous code. He reminded Illinois operators that they come into competition with the local mines of other States when they ship out of Illinois.

Many witnesses, beginning with F. G. Tryon, head of the economics division of the Commission, and James McSherry, director of the State Department of Mines and Minerals, testified to the practically inexhaustible coal reserves in the State and to the possibility of doubling and even trebling the present output with the mines and miners now available.

Gilbert W. Gambill and Frank H. Volker, of Terre Haute, Ind.; Roy Carson, of Cincinnati, Ohio, speaking for eastern Kentucky and southern West Virginia, and H. L. Richardson, for western Kentucky, all testified to the tonnage they shipped into Illinois and the manner in which it was distributed into practically every corner of the State in competition with coal locally mined and sold. Their testimony was corroborated by a long procession of wholesalers, retailers and traffic men, put on the stand by former Senator Essington, attorney for the Illinois producers' board. Distributors testified that price was the determining factor influencing consumers, industrial and domestic, to choose between Illinois and other coals. In most instances dealers said that the use of Illinois coal had increased in recent years, largely due to the cheapness of truck mining and to some extent to the perfection of stokers for burning this type of coal.

Sufficient evidence was presented orally and by exhibits to show that Maryland coal produced and consumed within the State is in active competition with coal sold in interstate commerce, said Robert W. Knox, general solicitor of the Commission, at a hearing under Sec. 4-A of the Guffey-Vinson act which closed on Aug. 31 at Cumberland. Mr. Tryon stated that generally Maryland coals are in direct competition with coals produced in adjacent fields. If Maryland coals were permitted to be sold with prices unregulated in competition with coals sold in interstate commerce under regulation, he added, there would be a definite and pronounced shift in sales in favor of the Maryland product.

States Line Crossed Often

Coals shipped from the Westernport area for transfer to the Western Maryland Ry., said William Clauss, general manager, Cumberland & Pennsylvania R.R., a subsidiary of the Consolidation Coal Co., crossed the Maryland State line five times while in transit. Forty-seven mines are located along the line of the road, he declared, with 67 manufacturing plants served. He concluded that, regardless of what line Maryland coals were shipped over from mining fields to consuming markets, they are shipped in interstate commerce.

Northern West Virginia producers have a rich market in Maryland, according to Mr. Shinnamon. He testified that Maryland coal competes with both low- and high-volatile coals produced in West Virginia, adding that rail shipments from his district were made into 21 counties in Maryland. He was emphatic in the opinion that if any Maryland coal is permitted to be sold unregulated, there will be disastrous effects on No. 3 district coal because of the similarity of freight rates for Maryland, West Virginia and Pennsylvania coals.

N. C. Ashcom, assistant to the president, Pennsylvania Coal & Coke Corporation, with mines in Clearfield, Cambria and Indiana counties, Pennsylvania, testified as to the nature and extent of competition with Maryland coals and reiterated that all coal should be regulated if the coal regulation act was to succeed. Charles F. Kirchner, head of the Knickerbocker Coal Sales Co., Baltimore, which sells 200,000 tons per year in Maryland, the tonnage being obtained from Maryland, western and central Pennsylvania, and northern West Virginia, also urged regulation. Arthur B. Stewart, president, Davis Coal & Coke Co., gave it as his opinion that it would be impracticable and impossible to regulate coal produced in one section of Maryland and allow that produced in some other State or section to be sold in the market without regulation.

Operators appealing for regulation of Indiana coal were joined by two officials of the United Mine workers at a hearing held Aug. 28 at Terre Haute. More than

★ ★

STOKER SALES TOP YEAR AGO

Sales of mechanical stokers in July last totaled 7,579 units, according to statistics furnished the U. S. Bureau of the Census by 108 manufacturers (Class 1, 59; Class 2, 39; Class 3, 40; Class 4, 33; Class 5, 10). This compares with sales of 8,717 units in the preceding month and 6,288 in July, 1936. Sales by classes in July last were: residential (under 61 lb. of coal per hour), 5,452; (bituminous, 5,976; anthracite, 476); small apartment-house and small commercial heating jobs (61 to 100 lb. per hour), 405; apartment-house and general small commercial heating jobs (101 to 300 lb per hour), 392; large commercial and small high-pressure industrial steam plants (301 to 1,200 lb. per hour), 250; high-pressure industrial steam plants (over 1,200 lb. per hour), 80.

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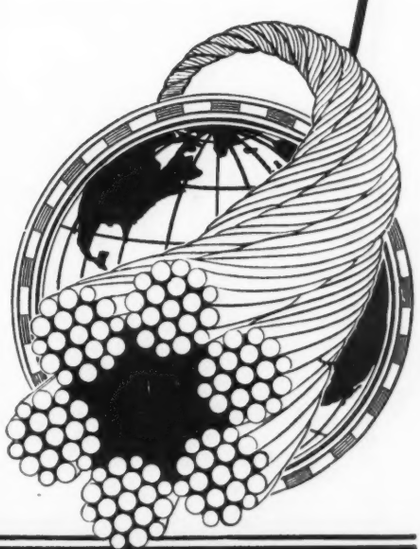

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fifty witnesses testified and 48 exhibits showing the extent of trade in interstate coal within the boundaries of the State were introduced.

Frank Barnhart, president, District 11, U.M.W., and Harmon Kelley, international board member of the union, both pled for regulation. A large number of truck mines in the State, said Mr. Barnhart, do not pay the wage scale, have no respect for hours or working conditions, and do not carry compensation to comply with the State law; they farm or do anything they can in the summer, and in the winter they mine coal and sell it for whatever they can get. He maintained that the sale of coal produced under such circumstances should be regulated; if not, it will have a bad effect on the sale of coal under regulation. Furthermore, said he, if the sale of all Indiana coal were regulated it would result in better working conditions and be more remunerative to those engaged in the industry.

District 7 (Southern No. 1) ships into the Indiana market two million tons of coal annually, said John A. Esley, Cincinnati (Ohio) district sales manager, Koppers Coal Co., and is in keen and active competition with Indiana coal, particularly for domestic use, at all consuming points. This competition, he added, takes the form of price at all times. Roy Carson, traffic manager, Harlan County Coal Operators' Association, said that Indiana is an important and vital market for District 8 (Southern No. 2) production.

James A. Reilly, Island Creek Coal Co., asserted that western Pennsylvania and West Virginia high-volatile coal, as well as Indiana coal, can be used in the same class of industrial plants and homes without any change in the burning equipment. G. Don Sullivan, executive secretary, Indiana Coal Merchants' Association, testified that 2,356 retail outlets in the State handled West Virginia, eastern Kentucky and also Indiana coal, all in direct and continuous competition.

Mine Fatality Rate Eases Slightly in July But Is Higher Than a Year Ago

ACCIDENTS in coal mines of the United States caused the deaths of 96 miners in July last, according to reports furnished the U. S. Bureau of Mines by State mine inspectors. This compares with 103 fatalities in the preceding month and 79 in July of last year. Production of coal in July of the present year was 34,307,000 tons, a decrease of 1,994,000 from the preceding month and also 1,413,000 tons less than in July a year ago. The fatality rate per million tons in July last was 2.80, a slight decline from the figure for the preceding month, which was 2.86, but considerably higher than that for July of last year, when the rate was 2.18; in July, 1935, however, the figure was 3.45.

For bituminous mines alone, reports show that 85 men lost their lives during last July in mining 31,610,000 tons of coal, the fatality rate being 2.69, as against 2.74 in the preceding month with 78 deaths and an output of 31,560,000 tons, and 2.41 in July, 1936, when there were 67 fatalities and 32,113,000 tons was produced.

In the anthracite mines of Pennsylvania, there were eleven deaths in July last in producing 2,697,000 tons of coal, as compared with 25 deaths in the production of 4,475,000 tons in June of this year and twelve fatalities in mining 4,127,000 tons in July of the preceding year. Death rates per million tons of coal mined were 4.08, 5.59 and 3.31, respectively.

Comparing the accident record for the first seven months of this year with that of the corresponding period of a year

FATALITIES AND DEATH RATES AT UNITED STATES COAL MINES, BY CAUSES *
January–June, 1936 and 1937

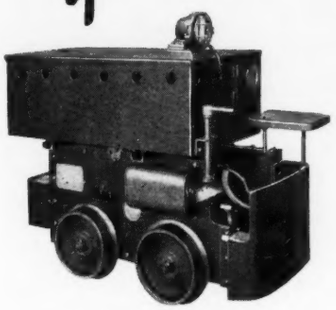
Cause	Bituminous: Number Killed		Bituminous: Killed per Million Tons		Anthracite: Number Killed		Anthracite: Killed per Million Tons		Total: Number Killed		Total: Killed per Million Tons	
	1936	1937	1936	1937	1936	1937	1936	1937	1936	1937	1936	1937
Falls of roof and coal	330	303	1.417	1.194	83	78	2.478	2.575	413	381	1.551	1.341
Haulage	93	123	.400	.485	12	19	.358	.628	105	142	.394	.500
Gas or dust explosions:												
Local explosions	13	8	.056	.032	11	....	.328	....	24	8	.090	.028
Major explosions	8	47	.034	.185	....	....	....	....	8	47	.030	.165
Explosives	15	17	.064	.067	10	9	.299	.297	25	26	.094	.092
Electricity	16	32	.069	.126	5	2	.149	.066	21	34	.079	.120
Mining machines	10	9	.043	.035	....	....	....	....	10	9	.038	.032
Other machinery	6	3	.026	.012	2	1	.060	.033	8	4	.030	.014
Miscellaneous:												
Minor accidents	17	20	.073	.079	16	7	.478	.231	33	27	.124	.095
Major accidents	....	....	....	....	....	....	....	....	....	....	....	....
Shaft:												
Minor accidents	6	11	.026	.043	6	3	.179	.099	12	14	.045	.049
Major accidents	....	....	....	....	....	....	....	....	....	....	....	....
Stripping or open-cut	7	4	.030	.016	4	5	.119	.165	11	9	.041	.032
Surface	15	37	.064	.146	10	11	.299	.363	25	48	.094	.169
Grand Total	536	614	2.302	2.420	159	135	4.747	4.457	695	749	2.610	2.637

* All figures subject to revision.

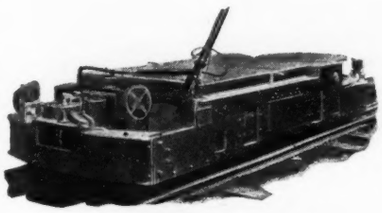
COAL-MINE FATALITIES IN THE UNITED STATES IN JULY, 1937, BY CAUSES AND STATES.

State	Falls of roof	Falls of face	Haulage	Gas or dust explosions	Explosives	Electricity	Mining machines	Other machinery	Suffocation	Mine fires	Other causes	Total underground	Persons falling down shafts	Objects falling down shafts	Struck by cage	Other causes	Total shaft	Mine cars	Railway cars	Falls of persons	Machinery	Electricity	Other causes	Total surface	Grand total
Alabama	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Alaska	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arkansas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Colorado	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Illinois	2	...	...	...	...	...	...	...	2	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	4
Indiana	1	...	1	20	...	...	...	...	...	...	...	22	1	...	...	...	1	...	...	...	...	...	...	...	23
Iowa	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Kansas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Kentucky	9	...	1	...	...	2	...	...	...	...	...	12	...	...	...	...	...	...	...	...	...	...	...	...	12
Maryland	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Michigan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Missouri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Montana	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
New Mexico	1	...	1	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	2
North Dakota	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ohio	2	...	...	...	...	...	...	...	2	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	4
Oklahoma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Pennsylvania (bit.)	8	...	2	...	1	1	...	...	...	...	1	13	...	...	...	...	...	...	...	...	...	...	...	...	13
Tennessee	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	1
Texas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Utah	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Virginia	2	1	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	3
Washington	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
West Virginia	8	1	5	...	...	3	...	...	...	...	1	18	...	...	...	...	...	...	...	...	...	...	1	1	19
Wyoming	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total (bituminous)	35	3	11	20	1	6	...	...	4	...	2	82	1	...	...	...	1	1	...	...	...	...	1	2	85
Pennsylvania (anthracite)	4	1	2	...	1	...	...	...	1	...	...	9	1	...	...	1	2	...	...	...	...	...	...	...	11
Grand Total	39	4	13	20	2	6	...	...	5	...	2	91	2	...	...	1	3	1	...	...	...	...	1	2	96

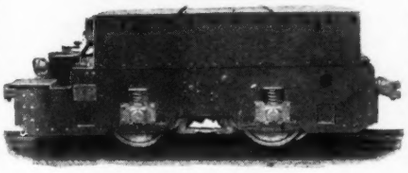
Every type— Any size you need



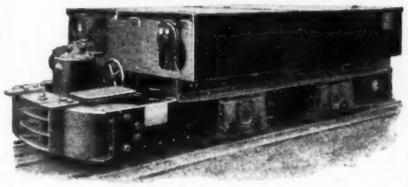
Storage-battery, Trammer



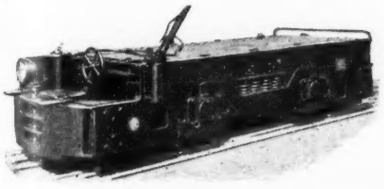
Cable-reel, Sealed Equipped



Storage-battery, Open Type



Storage-battery, Permissible



Trolley, Haulage

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MODERN HAULAGE EQUIPMENT MEANS FASTER, MORE ECONOMICAL PRODUCTION

190-10

GENERAL ELECTRIC

ago, a reduction is noted in the number of fatalities from falls of roof and coal, local gas or dust explosions, mining and other machinery, and stripping operations. Fatalities during July, by causes and States, as well as comparative fatality rates for the first seven months of 1936 and 1937, by causes, are given in the accompanying tables.

—❖—

Industrial Notes

Joy Manufacturing Co., Franklin, Pa., announces the appointment of Franklin E. Rhine, formerly sales manager of the Duncan Foundry & Machine Co., as service manager.

Goodman Manufacturing Co., Chicago, has appointed A. C. Green as sales manager. He has been connected with the sales department of the company since 1911, in recent years as manager of Western sales.

Lincoln Electric Co., Cleveland, Ohio, has opened a new sales engineering office at 400 North St., Bluefield, W. Va., in charge of William H. Schuster.

Westinghouse Electric & Manufacturing Co. has appointed Angus G. Scott as manager of line material activities with headquarters at East Pittsburgh, Pa.

Goodyear Tire & Rubber Co., Akron, Ohio, announces the following changes in its mechanical goods department: W. T. Roberts, salesman in the Seattle district, has been promoted to Northwestern district manager; R. W. Richardson, formerly of the Akron sales office, has been appointed technical man with headquarters in Chicago; J. H. Neiberding, formerly of the St. Louis office, has been transferred to the Memphis (Tenn.) territory; R. H. Thompson, formerly covering the Pittsburgh (Pa.) district, has been transferred to the New York offices; T. F. Stringer, formerly in the New Orleans (La.) office, has been transferred to Pittsburgh; C. O. Roome, formerly associated with C. T. Patterson Co., Inc., has been assigned to the New Orleans office; R. B. Snook has been assigned to the Jacksonville (Fla.) office to replace W. R. Barker, who has been transferred to Knoxville, Tenn.; R. S. Chiseler has been assigned to the Omaha (Neb.) district to replace C. E. Cattell, who has been transferred to Chicago.

Laminated Shim Co., Inc., Long Island City, N. Y., has appointed Richard Seipt as sales manager.

Falk Corporation, Milwaukee, Wis., has appointed P. C. Day as vice-president. He became connected with the company in 1910 as chief engineer to direct the work of pioneering helical and herringbone gearing in this country.

Harnischfeger Corporation, Milwaukee, Wis., has appointed C. H. Boenig as sales engineer for western New York.

Trico Fuse Manufacturing Co., Milwaukee, Wis., announces the appointment of the Delavan Engineering Co., 414 Fourth St., Des Moines, Iowa, as sales representative in Iowa and Nebraska.

Duraloy Co., Scottdale, Pa., announces that W. C. Schade, St. Louis, Mo., has been appointed Mid-Western representative.

LETTERS
To The Editor

Increase Pipe Size

Referring to the August issue of *Coal Age*, pp. 364-365, and its discussion of the cost of pumping water from coal mines, I find myself in hearty agreement with H. B. Samson when he says that "at some mines the weight of water pumped is from ten to fifteen times the weight of coal mined." Everyone will concede that a low pumping cost is an important stride toward a low production cost for coal.

At many of the smaller mines, pumps labor against a friction head three to ten, or even more, times the actual weight of water discharged, in many instances due to the fact that the pipe was installed when much less water had to be pumped. Many times the only question asked is whether the pipe will carry the increased volume of water, not whether it will carry it with due economy. Such a query should never be made, for in almost every case the use of such a small pipe will increase the friction head unreasonably.

Referring to the tabulated data section of the "Coal Mining Catalogs" of the McGraw-Hill Publishing Co.:

A 3-in. pipe will carry 2.8 times as much water as a 2-in. pipe;

A 4-in. pipe will carry 5.7 times as much water as a 2-in. pipe;

A 4-in. pipe will carry 2.1 times as much water as a 3-in. pipe;

A 5-in. pipe will carry 9.9 times as much water as a 2-in. pipe;

A 6-in. pipe will carry 5.7 times as much water as a 3-in. pipe;

A 6-in. pipe will carry 15.6 times as much water as a 2-in. pipe—that is, when the same pressure is applied.

When clean cast-iron pipe is used and the discharge rate per minute is held to 250 gal. through 1,000 ft. of pipe length, the friction head is, as given by the same authority:

For 4-in. pipe, 43.47 ft. or 18.83 lb. per square inch.

For 5-in. pipe, 16.24 ft. or 7.08 lb. per square inch.

For 6-in. pipe, 6.00 ft. or 2.60 lb. per square inch.

For 8-in. pipe, 1.52 ft. or 0.66 lb. per square inch.

Over 18 lb. per square inch of friction head could be reduced to less than 1 lb. if an 8-in. pipe were used instead of a 4-in. pipe. To make a real picture of this difference, the friction head would be 28.53 times as great with a 4-in. pipe as with one of 8 in., or 18.83 ÷ 0.66.

When the discharge rate is increased, say, to only 600 gal. per minute, the friction head is increased for a 5-in. pipe to 90.2 ft., or 39.3 lb. per square inch. Thus the increase in volume from 250 to 600 gal. per minute raises the friction head from 7.08 to 39.3 lb., multiplying the friction head 5.55 times.

In the event that a mine produces ten times as much water as coal and this against a friction head of, say, three times the weight of the water, the water extraction cost will be 30 times as great as if one ton of water per ton of coal had to be raised and the friction head had not been increased. A mine with difficult water problems competes with difficulty with one that has none, for actual water head is 1 lb. per square inch for every 2.31 ft. of rise from suction to discharge points.

The rather large contrasts as given will show that inadequate pipe-line sizes mean the loss of many kilowatt-hours of energy and a big increase in dollars and cents for current.

E. A. Smith,
Chief Engineer,
Central Elkhorn Coal Co.,
Estill, Ky.

—❖—

Break in Roof, Not Floor

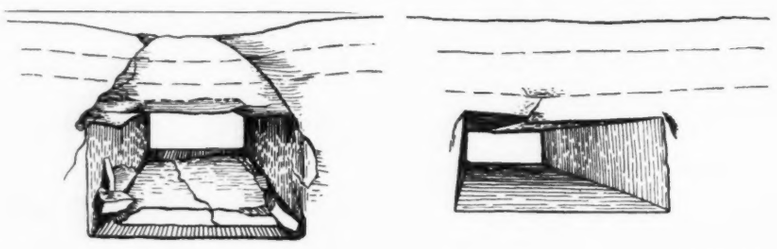
I was very much interested in the review of the Fourteenth Annual Report of the Safety in Mines Research Board in *Coal Age* of May, 1937, and was sorry to find that the author had been misled by one of the photographs showing the results of tests on models simulating mining conditions.

In your drawing showing the effect of strong sides there is a center floor crack shown. This was not the case; the crack was in a roof layer which had fallen, as shown in the inclosed drawing. Further, the model structures simulated bedded strata; in each case there were three roof beds and the horizontal fracture seen in the structure with weak sides is really an opening along a "bedding plane."

I agree with you that more details of these tests are desirable for complete explanation, and hope to publish a full report at a later date.

H. T. Foster,
Mining Engineer
Safety in Mines Research Board
Sheffield, England

Roof collapse with strong sides (left) and with weak sides (right)



ADVERTISING PAGES REMOVED

WHAT'S NEW

In Coal-Mining Equipment

CLAMSHELL BUCKET

Hayward Co., New York City, offers the class E-15 grab bucket for coal, coke and similar bulk materials, said to be built to a weight of close to 1 lb. of bucket for each pound of material carried.

Modern light-weight aluminum-alloy construction, it is stated, makes this increase in capacity possible and at the same time gives increased strength.

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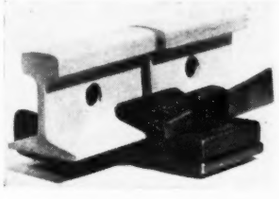
RAIL SPLICER

Resistance to corrosion and shock and smooth true-to-pattern surfaces are stated to be responsible for the use of malleable iron in the manufacture of a new rail splicer offered by the Portable Lamp & Equipment Co., Pittsburgh, Pa. The



new splicer is said to eliminate the use of fishplates, bolts and nuts and to be distinguished by great ease and speed of application. Main section, wedge plate and wedge comprise the new unit, which comes in direct contact with three sides of the rail when applied. Ease of application under all conditions, according to the company, eliminates the hazard of improperly fastened fishplates and also corrosion of bolts and nuts by mine water.

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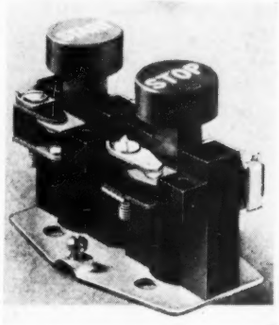
PUSHBUTTON

Monitor Controller Co., Baltimore, Md., has added the pushbutton station illustrated to its line of master-control equipment. Features cited by the company include: substantial construction; liberal-sized pure-silver contacts mounted on a molded Bakelite base; box tapped for conduit entrance,



making wiring possible by removing the cover without disturbing internal connections; molded Bakelite buttons; and a wide variety of contact arrangements with suitable button markings.

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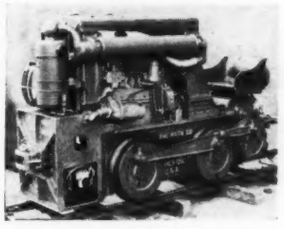
DIESEL LOCOMOTIVE

Among the line of diesel-powered mine locomotives built by the Ruth Co., Denver, Colo., is a unit with a gas scrubber for reducing the temperature of the exhaust gases from about 800 to 900 deg. F. as they leave the engine to about 140 deg. on leaving the scrubber. Operation of the scrubber requires about 1 qt. of distilled water for eight hours of engine service, and back pressure is said to be so small as not to affect



appreciably engine operation. The scrubber appears in front of the radiator in the accompanying illustration.

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MORTAR LIQUID

To make mortar easier to work with a smaller percentage of water, and thus reduce the effects of shrinkage upon subsequent evaporation, Truscon Laboratories, Detroit, Mich., offer "Mortite." When added to brick mortar in small quantities, according to the makers, "Mortite" liquid makes it very workable and consequently lessens water requirements.

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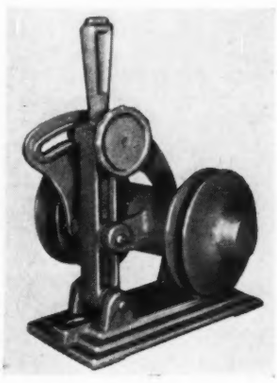
VARI-SPEED CONTROL

Columbia Vari-Speed Co., Wheaton, Ill., now offers the "HI-EFF" variable-speed control, said to incorporate the adjustable V-pulley principle in a new single-shaft design. The transmission consists of a single shaft on which are two adjustable V-belt pulleys varying in speed as their distances from



the driving and driven pulleys are changed. Offered in sizes from ¾ to 7½ hp., the unit is said to provide infinite speed selectivity within the ratios of 5 to 1 at an efficiency of over 90 per cent. Features cited by the makers include: single-shaft design, compactness, efficiency, economy, one-place lubrication, self-centering compensatory pulleys, ease of installation, and use of standard V-belts.

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PUMP CONTROL

For starting and stopping electric boiler-feed pumps in accordance with boiler-water level, McDonnell & Miller, Chicago, offer the McDonnell No. 150 high-pressure combination pump control and low-water cutoff. If, for any reason, the pump should stop and the level of water in the boiler drop abnormally, the cutoff will stop the fuel feed and sound an alarm.

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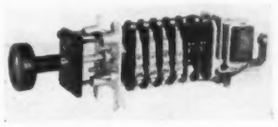
RELAYS

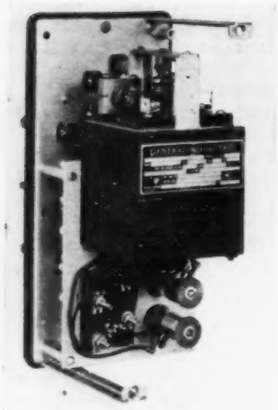
A new high-speed hand-reset multi-contact auxiliary relay for switchboard mounting (Type HEA) is offered by the General Electric Co., Schenectady, N. Y., to supersede the previous Type PB-58 multi-contact unit. The new relay is available in two models: HEA11A, six-circuit contacts, and HEA11B, ten-circuit contacts. Operating in 20 milliseconds (1¼ cycles), this relay is said to be particularly applicable where a number of operations are to be performed simultaneously, such as:



tripping the main circuit of a circuit, tripping an auxiliary breaker, opening a neutral breaker, sounding an alarm and operating other relays in turn performing various functions.

Principal parts of the HEA relay are an SB-1 switch with three torsion springs to throw the contacts to the "operated" position when the trip coil is released. A small capacitor under the coils reduces arcing of the coil circuits of 125- and 250-volt relays. Contacts are silver-to-silver and will carry 20 amp. continuously or 250 amp. for three seconds.

General Electric also offers a new polyphase power directional relay (Type CBP) with two "cup-type" torque-producing elements on one shaft. One element is a polyphase power-directional element. The other is a voltage-restraint element, giving a directional relay which



normally stays in the open position. When a fault occurs, the voltage restraint collapses, allowing the directional element full control. In addition to its use as a crude polyphase impedance relay, the CBP is said to give very satisfactory "directional control" and can be used even with instantaneous as well as delay overcurrent relays because it cannot close its tripping contacts on load current. Only the control voltage is on the contacts, so there is no chance of not making contact as a result of low voltage or difficulty in short-circuiting overcurrent relay coils of low impedance.

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CHANNEL ROOFING

Republic "perfected triple-drain channel roofing" is a new product of the Republic Steel Corporation, Cleveland, Ohio. A major feature, it is pointed out, is in the use of four ridges and three valleys in each channel unit, thus providing three drainage channels instead of the conventional one or two. As a result, it is asserted, neither driving rain nor capillary attraction can cause leaks. A beaded channel makes a tight fit at the overlapping edge, creating a vacuum action. Any rain passing this point is carried into the center channel by the action of gravity. For convenience, the proper area for nailing triple-drain roofing is indicated by blue lines on each sheet. The roofing is available in steel, copper-bearing steel and rust-resisting Toncan iron in gages of 26, 28 and 29 and in lengths of from 5 to 12 ft. with a covering width of 24 in.

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POWER FUSE

For service in medium-capacity generating stations and substations of all types where the short-circuit capacity does not exceed 600,000 3-phase kva., a new 34.5-kv. 200-amp. disconnecting-type BA "De-ion" power fuse has been developed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. This light-weight fuse, it is stated, can be lowered to the ground readily for inspection or refilling. The complete operation of removing the fuse from service, refilling and restoring service can be accomplished in less than one minute of time, it is asserted. The fuse is hinged at the lower contact to open approximately 75 deg. for use as a hook-operated disconnect, which will interrupt the magnetizing currents of a 750-kva. three-phase transformer easily.

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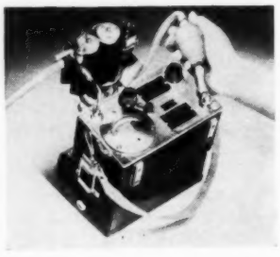
GAS INDICATORS

Linde Air Products Co., New York City, offers a new line of gas indicators said to be developed for quickly and easily detecting explosive or irrespirable gas-air mixtures. These UCC gas indicators are available in three models. The UCC combustible gas indicator (Model 12-B) is offered for the detection of combustible gases or vapors. A graduated meter scale indi-



cates by direct reading whether combustible gases are present and, if they are, whether the concentrations are above, within or below the explosive limits. For increasing the utility of this instrument, a flame-safety-lamp attachment is available which makes it possible to detect oxygen deficiencies also.

The UCC all-service indicator (Model B-1, illustrated) combines three units in one and shows the presence of combustible gases, indicates an oxygen deficiency and includes a toxic chamber for determining the presence of carbon monoxide and hydrogen sulphide in dangerous concentrations. Both the combustible-gas and all-service indicators, according to the company, are equipped with an air-dilution valve which permits diluting incoming samples with any volume of air, thus making it possible to detect flammable conditions which might otherwise remain unobserved due to a lack of oxygen. It also permits following a complete purging operation from start to purge-end point with an inert gas as a purging medium.

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REGULATOR

A two-element steam-flow-type boiler-feed-water regulator, known as the Copes "Flow-matic," has been announced by the Northern Equipment Co., Erie, Pa. This regulator, according to the company, meets the demand for more accurate control on modern high-rating boilers and on other units subject to rapid, wide load fluctuations. The boiler is fed according to the rate of steam flow, and a higher water level can be maintained on heavy loads than on light or a practically constant level can be maintained for all ratings. The regulator is available in all pressure standards from 250 lb. up with 2- to 6-in. valves.

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15-CU.YD. BUGGY

A new 15-cu.yd. (heaped-measure) pneumatic-tired buggy designed primarily for use with shovels and draglines in material too hard for scraper loading, and for rock jobs, long hauls, handling ore and gravel, etc., is announced by R. G. LeTourneau, Inc., Peoria, Ill. The unit, weighing 14,500 lb., is built for use with a Caterpillar RD7 or RD8 tractor and is cable-controlled by LeTourneau single- or double-drum power units, the latter for tandem operation. In unloading, the body moves backward over the bed, pushing the load through an ever-widening opening to the rear so that the wheels do not travel over the material as it is discharged. Extended dimensions of the opening are 7 ft. 10 in. by 9 ft. 10 in.—large enough to make unloading boulders easy. The buggy is said to maneuver like a two-wheeled cart and consequently is easily spotted. The large body makes unnecessary careful shovel or dragline spotting.

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STEAM HOSE

B. F. Goodrich Co., Akron, Ohio, announces a new burst-proof steam hose which it states will leak upon failure but cannot burst unless given an external blow severe enough to cut the wire reinforcement. It is recommended for a working pressure of 200 lb., with a safety factor of 15 to 1 in larger diameters and 35 to 1 in smaller diameters. Sizes range from ⅜ to 2½ in.

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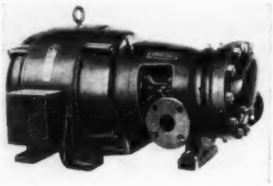
TWO-STAGE PUMP

Fairbanks, Morse & Co., Chicago, offers a two-stage built-together pump (pump and motor built together) for heads up to 500 ft. and liquids low in viscosity and free from excessive foreign matter. In many applications, according to the company, the new pump offers a less-expensive alternative for multi-stage and split-case pumps and its compactness and strength qualify it for portable and semi-portable as well as



stationary service. No special foundation is required and the unit may be mounted in any convenient horizontal, vertical angular position.

This new built-together pump consists essentially of a two-stage centrifugal pump with inclosed bronze impellers mounted directly on the shaft of an F-M splash-proof motor, eliminating flexible couplings and alignment problems. Two strong ball bearings take care of all radial and unbalanced thrust loads. Impellers for the two stages are placed back to back to compensate thrust. Improved hydraulic design, it is stated, is attained by placing the first-stage unit next to the motor and the second stage on the outside, simplifying the cross-over passage and placing the stuffing box under suction instead of pressure. A mounting leg under the pump end gives the unit added stability.